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ABSTRACT

This curriculum guide contains 33 interdisciplinary energy and environmental education activities to help students become familiar with past, present, and alternative sources and forms of energy as well as the economic and environmental cost of energy consumption. Each activity, designed to meet one of five objectives, includes: (1) statement of topic or concept fostered; (2) list of materials needed; (3) teacher information; (4) procedure(s); and (5) evaluation methods. Materials to accompany selected activities, list of goals and objectives for energy education in San Diego County, and energy fact sheets are provided in appendices. Also provided in introductory sections are: brief comments for teachers on energy sources, energy forms, and renewable and non-renewable energy sources; sources of additional energy materials (including organization name and address); list of suggested art activities; and instructions for preparing a bulletin board on "energy in the news." (JN)

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an ENERGY ENVIRONMENT EDUCATION

Program for Grade 6

Superintendent of Schools, Department of Education, San Diego County

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SE043 911

ENERGY/ENVIRONMENT EDUCATION

GRADE 6

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1977

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1978
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PREFACE

Nature never gives anything away.
Everything is sold at a price.
It is only in the ideals of abstraction
that choice comes without consequence.

--Ralph Waldo Emerson

In 1976 America celebrated its 200th birthday. For about 195 of these 200 years Americans were coaxed, implored, and cajoled to consume, consume, consume. Even the hearty pioneer viewed the forests and prairies as something to be conquered and used and, when they wore out, to move on. In later years the massive efforts of Madison Avenue were to convince Americans that they should buy "more" and "bigger" everything. By the 1950's and 60's the automobile had become a symbol of wealth and prestige, and the value of an automobile was measured by its horsepower, its power equipment, and the amount of chrome it carried. Americans were led to believe "there was no tomorrow" or that tomorrow would be even more rosy than today.

Occasionally in our history we had small warning signs, such as the dust bowl of the 1930's, but generally the cries of the conservationist and the ecologist were brushed off as being those of doomsday sayers and of the radical fringe. It is no wonder then that Americans were genuinely surprised and shocked when they had to stand in gasoline lines in 1973. Other warning signs quickly followed in the form of blackouts and brownouts in major American cities. In the winter of 1976-77 most of the East Coast of the United States suffered from severe shortages of natural gas and other heating fuel. By the bicentennial year gasoline rationing was a topic for serious consideration.

And so, as the nation enters its third century, Americans' views on energy and the environment are slowly beginning to change, often against their will. But the task of re-educating the American people to a more sensible and rational perspective on energy and environment has only just begun. Adults trained for most of their lives to believe that there is an endless supply of energy and natural resources continue to question the need for conservation. Their attitudes are epitomized by a recent newspaper article from drought-stricken Marin County which told of a young man washing down his driveway with water which should have been put to much better use. When confronted, he replied, "I can afford it, can't I?" and the newspaper caption read, "Yes, but can we afford you?"

Deeply engraved attitudes of indulgence and waste are still being passed on to children. We still live in the disposable, throwaway, bigger and faster age. Energy and environmental constraints indicate that this life-style can no longer continue.

America's schools are often called on to bring about change of attitude in American society. Undoubtedly, then, it would be the schools that play the leading role in helping the new generations to develop healthier and more rational views of energy and the environment. It was with this in mind that this curriculum project was undertaken. It is the sincere hope of all who worked on it that the ideas and activities contained in this project will be an initial step in helping the children of our schools develop thought patterns and actions which will result in a more thoughtful use of energy and the environment.

ORIGINS OF THIS PROJECT

For the past three years, a committee consisting of representatives from San Diego City Schools, San Diego County Schools, and a variety of community groups has been meeting to discuss energy education plans for San Diego County. This group is known as the San Diego City/County Energy Education Committee. In the fall of 1976, a subcommittee met and formulated a proposal for a funding grant from the State of California Environmental Educational Grant Fund (state individualized license plate money). The grant was awarded and in the spring of 1977 a review of all available materials related to energy education was undertaken.

In the summer of 1977, a major curriculum writing project was undertaken which resulted in the production of primary grade and upper elementary grade curriculum guides containing activities and materials for teaching energy and environmental education in the classroom. This writing was undertaken by the elementary resource staff members of social studies and science from San Diego City Schools assisted by eight elementary classroom teachers. The result is a publication which contains practical classroom activities arranged in a thoughtful sequence. The writing team consisted of persons with expertise in social studies, science, and art and has given a multidiscipline perspective to energy/environmental education.

During the summer of 1978, a major rewriting of the energy/environment guides was undertaken. A team of city and county school teachers worked together to produce guides for grades 1, 3, 4 and 6. The guides for grades 1 and 4 emphasize basic science concepts involving energy that will enable students to apply that knowledge to social issues in grades 3 and 6. Grades 2 and 5 will utilize the SDG&E materials.

The continuing need for energy/environmental education is apparent, since the factors related to our energy/environmental status is constantly changing. Energy/environmental education cannot be static. It must continue to change to better assist students in making wise decisions as they become the energy consumers of the future.

GOAL AND OBJECTIVES

Goal: Students will become familiar with past, present and alternative sources and forms of energy and the economic and environmental cost of energy consumption.

Objective 1: Students will identify energy forms and conversions, renewable and non-renewable sources of energy.

Objective 2: Students will explain energy epochs.

Objective 3: Students will identify some present environmental concerns that are energy-related.

Objective 4: Students will identify advantages and disadvantages of some possible future energy sources.

Objective 5: Students will recognize the need for all citizens to accept social responsibility in decisions about energy use.

SOURCES OF ENERGY MATERIALS

In addition to the library materials you have available for classroom use, you may want to acquire additional material by visiting San Diego Ecology Centre, 340 Kalmia St., San Diego, CA 92101 (714-235-0066) and by writing to the sources listed below.

American Gas Association
1515 Wilson Boulevard
Arlington, VA 22209

American Nuclear Society
San Diego Chapter
P. O. Box 81451
San Diego, CA

American Nuclear Society
National Office
244 East Ogden Ave.
Hinsdale, IL 60521

American Petroleum Institute
1801 "K" Street NW
Washington, DC 20006

American Public Power Association
2600 Virginia Avenue NW
Washington, DC 20037

Atomic Industrial Forum
475 Park Avenue South
New York, NY 10016

Citizens' Advisory Committee on
Environmental Quality
1700 Pennsylvania Ave. NW
Washington, DC 20006

Ecology Forum
124 East 39th Street
New York, NY 10016

Edison Electric Institute
90 Park Avenue
New York, NY 10016

Thomas Alva Edison Foundation
Cambridge Office Plaza, Suite 143
18280 West Ten Mile Rd.
Southfield, MI 48075

Electrical Industries Association
6055 E. Washington Blvd
Los Angeles, CA 90040

Energy Conservation Research
9 Birch Road
Malvern, PA 19355

Energy Information Center
100 California St.
San Francisco, CA 94111

Energy Research and Development Adm.
Dept. of Energy
Office of Public Affairs
Washington, DC

Environmental Action Foundation
724 Dupont Circle Building
Washington, DC 20036

EXXON, USA
Public Affairs Dept.
P. O. Box 2180
Houston, TX 77001

Federal Energy Administration
Dept. of Energy
111 Pine Street
San Francisco, CA 94111

Foundation for Alternative Energy
407 N. Maple Drive
Beverly Hills, Ca 90210

Interstate Oil Compact Commission
Educational Department
P. O. Box 53127
Oklahoma City, OK 73105

National Coal Association
1130 17th St. NW
Washington, DC 20036

National Interviews
153 E Street SE
Washington, DC 20003

National Solar Heating and Cooling
Information Center
P. O. Box 1607
Rockville, MD 20850

National Audubon Society
1412 - 16th Street NW
Washington, DC 20036

San Diego Ecology Centre
340 Kalmia St.
San Diego, CA 92101

San Diego Gas and Electric
P.O. Box 1831
San Diego, CA 92112

Scientists Institute for Public
Information
30 East 68th St.
New York, NY 10021

Shell Oil Company
Public Affairs
P. O. Box 2463
Houston, TX 77001

Sierra Club
1051 Mills Tower
San Francisco, CA 94104

Sierra Club San Diego Chapter
1549 El Prado
San Diego, CA 92101

State Energy Resources Conservation
and Development Commission
1111 Howe Ave.
Sacramento, CA 95825

U.S. Environmental Protection Agency
401 "M" Street SW
Washington, DC 20240

U.S. Department of Interior
18th and C Street NW
Washington, DC 20240

TEACHER BACKGROUND

Energy Sources

The sun is the ultimate source of nearly all of the energy consumed on earth. (The exception is nuclear energy.) Most people are unaware of this, because the manner in which solar energy comes to our use is frequently obscured by intermediate steps.

Convection and evaporation are two of these processes. Convection makes the sun's energy available to us quickly and more or less continuously. Heat is converted to air motion, but there is no significant storage of energy. Evaporation also depends on continued heating, but at any given moment there is an appreciable amount of energy stored in water previously lifted which has not yet returned to sea level.

The most important process through which solar energy comes to our use is called photosynthesis. Photosynthesis is the process by which every green plant is able to use solar energy *directly* to do the work necessary to build its own complex molecular structures from the simpler molecules in the plant's environment. This process is important because (1) it is the beginning of the food chain, which provides energy to all living things, and (2) it is the origin of all fossil fuels.

If plants provide fuel for the other living things, it follows that the growth of plants must be a process of energy storage. The energy is stored in the chemical bonds which hold the plant's molecules together. It is put into storage when the molecules are assembled during growth. It may be taken out by digestion, combustion, or any other process which disassembles the molecules.

What we now know as fossil fuels are ancient deposits of plant and animal life. Coal has been changed by varying amounts of time, heat and pressure to its present high carbon content forms. Petroleum consists of the remains of marine plants and animals which, though long dead, still contain large, complex molecules whose connecting bonds yield abundant energy when the bonds are broken. This biological process yields food as well as fuel.

Every living thing on earth which does not have photosynthesis capability *must* feed, directly or indirectly, on things which do. Every animal, for example, eats either vegetable matter, or it eats other animals which eat vegetable matter.

Energy Forms

The forms of energy are somewhat arbitrary divisions of a single thing: energy, which is the capacity to do work. These divisions are useful in predicting the properties of a particular form of energy, or in understanding where certain energy comes from. Related to the concept of forms of energy is the knowledge that energy can be converted from one form to another. Energy conversion takes place all around us all the time. Conversion processes are the link which connects the systems which consume energy (living things, geophysical systems such as weather, machines, etc.) with earth's primary energy source, the sun.

Heat energy is converted to mechanical energy during evaporation, in that water is lifted, and during convection, in that air is set in motion. Light energy is converted to chemical energy during photosynthesis. A flashlight cell releases electrical energy which it converts from chemical energy stored in it during manufacture. Electrical energy is, in turn, converted to light and heat energy in the flashlight bulb.

Energy which is stored is more difficult to observe than is energy in action. For example, any combustible material is a storehouse of chemical energy. It is only when the energy is released, in the dramatic display of fire that we become conscious of its presence. Food energy is another example of chemical energy. Digestion is the process which releases it for use by living organisms.

Renewable and Non-renewable Energy Sources

The energy which reaches us from the sun may be divided as follows:

1. Energy which is continuously available. We can use it all without using it up.
2. Energy which is replenished fairly rapidly. If we are careful, it won't be used up.
3. Energy which takes so long to replenish that once we use it up, we won't live until it is replenished.

The energy in wind and falling water is constantly replenished by the sun (during daylight hours). This continuously available energy is like a salary paid at regular intervals. In contrast, let us look at vegetation, a savings account which is often replenished, and fossil fuels, a long-term savings account.

Vegetation is a quickly replenished savings account for energy. Wood can be produced in a generation or less. A substantial amount of alcohol can be produced by fermentation of a single year's crop of a starchy material, such as potatoes. Both wood and alcohol can be burned to produce steam which, as you know, can do a lot of work. Alcohol can also be used in automobile engines. So long as we don't use it faster than nature can produce it, this sort of energy is inexhaustible.

In contrast, fossil fuels, such as coal and petroleum, were formed millions of years ago and required at least tens of thousands of years to form. Most important, they are being replenished, if at all, at a rate which would require us to wait hundreds of generations for new deposits to form. Imagine a checking account containing a million dollars which is replenished at a rate of five hundred dollars a year. It seems like a lot, but, once the balance is spent, it will take many lifetimes to replenish it. Fossil fuels are non-renewable in the sense that neither we, nor our great-great-grandchildren, nor any later generation we can imagine, will be around to see them replaced. There is a lot of controversy as to how much fossil fuel is left on earth, but it seems clear that at our present rate of consumption we will use up in two to ten generations the energy savings that it took hundreds of generations to accumulate.

BULLETIN BOARD--"ENERGY IN THE NEWS"

Learning: Energy is in the news--locally, statewide, nationally and globally.

Materials: A bulletin board, news articles.

Teacher Information: During the course of this unit, there will be articles in the newspaper and/or in magazines that will have a particular relevance to the concepts being developed. A bulletin board (perhaps entitled "Energy in the News") would keep information up-to-date and would reinforce the growing importance of energy issues to all of us.

Procedure: The bulletin board might be divided into the four categories listed in the learning, so that, as the article is reported, it could be placed in the appropriate section to reinforce the geographic perspective of the article.

Have students bring in newspaper and/or magazine articles. Have the student summarize the article for the the class. Discuss the article so that it is meaningful to students.

Add the article to the bulletin board, having the student place it in the appropriate section.

Evaluation: At the end of each week, do a quick inventory of the bulletin board to see what the energy news for the week was:

1. What energy sources were reported?
2. What specific energy problems were identified?
3. Were the articles mostly local? State? National? Global?

SUGGESTED ART PROJECTS

1. Make a giant scrapbook or accordion of pictorial representations of energy concepts. Make it accessible to the children throughout the time that the unit is being studied.

2. Certain projects are designated as murals, posters, charts, collages, etc., primarily to add variety to the kinds of projects being done. Any project suggested as a mural could be compressed into a scrapbook page. The opposite is also true.

3. Since one of the major behavioral objectives is the conservation of energy, use scrap or discarded paper, or paper that has already been used on one side. For example, two murals, charts, or posters could be made back to back on the same piece of paper.

4. Have children bring in plastic containers from home to hold water, art materials, and serve as palettes.

5. Teach children to use all art materials conservatively, since wasting art materials costs both money and energy.

6. Some children may want to make individual scrapbooks or folders during their study of energy. Encourage them to do so.

7. Whenever possible display art projects where other children in the school can see them, so that they will become more aware of the energy problems.

8. Remember that aesthetics are important in all art projects even though the purpose of these projects is to teach about energy. The children should always be encouraged to make their projects attractive and to evaluate them from that point of view.

ACTIVITIES

GOAL: STUDENTS WILL BECOME FAMILIAR WITH PAST, PRESENT, AND ALTERNATIVE SOURCES AND FORMS OF ENERGY AND THE ECONOMIC AND ENVIRONMENTAL COST OF ENERGY CONSUMPTION.

OBJECTIVE 1: *Students will identify energy forms and conversions, renewable and non-renewable sources of energy.*

ACTIVITY 1

Learning: Review of energy concepts.

Materials: "Questions" (Appendix A-1), "Gameboard" (Appendix A-2)

Teacher Information: You may use this game to assess students' understanding of energy concepts.

These are comments on the false statements:

3. A force always does work. FALSE
Motion and force both must be present for work to have been done in a scientific sense.

5. Plants and animals can convert and store energy directly from the sun. FALSE
Plants can, using photosynthesis. Animals cannot. We are dependent upon plants in the food chain.

9. The energy stored in fuel is in the form of mechanical energy. FALSE
The form is chemical energy. Mechanical energy is moving energy.

10. Kilowatt hours are units used in measuring natural gas consumption. Therms are used in measuring electricity consumption. FALSE
Just the reverse.

11. Fusion releases nuclear energy by splitting atomic nuclei. FALSE
Fission is the process which does this.

13. The energy in moving water is not related to solar energy. FALSE
Evaporation (by sun's heat) lifts water which then flows downhill.

16. Nuclear energy cannot be used to make electricity. FALSE
It is used, e.g., by SDG&E at San Onofre.

QUESTIONS

(Begin at the triangle.)

1. A source of energy is considered nonrenewable if no more of it can be produced or if it takes so long that we can't wait.

   If this is true, move up.
   If this is false, move down.

2. Forces can be natural or man-made. An example of a natural force is wind.

   If this is true, move up.
   If this is false, move down.

3. A force always does work. (scientific definition)

   If this is true, move up.
   If this is false, move down.

4. Moving (mechanical) energy can change into sound, heat, and/or light energy.

   If this is true, move up.
   If this is false, move down.

   The letter is ☐ (1)

   Begin again at the triangle. Move up on the gameboard for true statements, move down for false statements.

5. Plants and animals can convert and store energy directly from the sun.

6. Energy can be transferred to make other things move.

7. A battery, a potato, and coal all are examples of stored energy.

8. Combustion releases energy stored in organic materials.

   The letter is ☐ (2)

   Begin again at the triangle.

9. The energy stored in fuel is in the form of mechanical energy.

10. Kilowatt hours are units used in measuring natural gas consumption, therms are used in measuring electricity consumption.

11. Fusion releases nuclear energy by splitting atomic nuclei.

12. Electrical energy can be converted to heat energy, light energy, or mechanical energy.

    The letter is ☐ (3)

Begin again at the triangle.

13. The energy in moving water is not related to solar energy.

14. Food has the sun's energy stored in it.

15. The sun is the source of energy for winds.

16. Nuclear energy cannot be used to make electricity.

The letter is ☐ (4)

Begin again at the triangle.

17. Through photosynthesis, a tree can change the energy in sunlight to chemical energy.

18. Fuels are commonly used to supply heat energy to produce electricity.

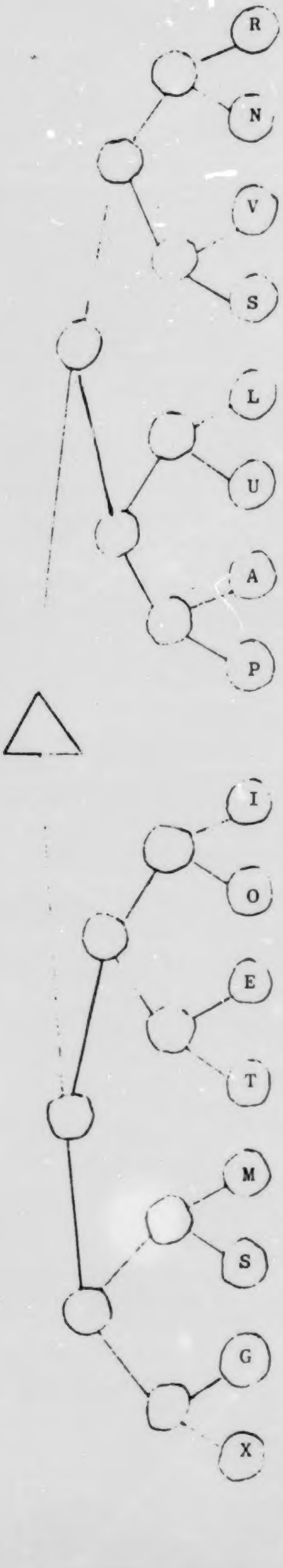
19. Fission and fusion are methods to release nuclear energy.

20. Cosmetics, drugs, dyes, fabrics, fertilizer, paints, styrofoam packing are all petroleum chemical products.

The letter is ☐ (5)

ANSWER KEY

Name ____________________



To identify each letter, begin at the triangle. If the statement is true, move up. If the statement is false, move down. Moves are supplied below.

1 ↑   5 ↓   9 ↓   13 ↓   17 ↑

2 ↑   6 ↑   10 ↓   14 ↑   18 ↑

3 ↓   7 ↑   11 ↓   15 ↑   19 ↑

4 ↑   8 ↑   12 ↑   16 ↓   20 ↑

V I G O R

ACTIVITY 2

Learning: Nearly all of the energy we use is supplied by the sun. The sun's energy is transformed into many forms.

Materials: "Energy" chart (Appendix A-3); energy diagrams "Electricity from Water," "Electricity from Gas Turbines," "Electricity from Fossil Fuels" (Appendix A-4); "Energy Word Search" (Appendix A-5).

Teacher Information: This lesson begins by asking students to identify a phenomenon in which energy is being expended. (Expenditure rather than use since the expenditure of energy is not necessarily purposeful, for instance, Niagara Falls.) The expenditure of energy can have a number of effects. Some of these are directly observable with the senses and some are not. The most common effects of expended energy which are directly observable are heat, light and motion. To observe the expenditure of chemical and electrical energy may require the use of measurement instruments, which constitutes a kind of indirect observation.

1. *Energy:* the capacity for doing work
2. *Effect of energy:* heat, light, motion
3. *Forms of energy:* heat, light, electrical, chemical, mechanical, and nuclear
4. *Intermediate sources:* foods, fuels, wind, water power, nuclear
5. *Primary sources:* sun, nuclear energy

For additional information, see Teacher Background: Energy Sources, page 6; Energy Forms, page 6; and Renewable and Non-Renewable Energy Sources, page 7.

Procedure: Elicit from students a phenomenon in which energy is expended. Have students:

1. Identify the observed effect of the energy.
2. Identify the form of energy which is expended.
3. Identify the immediate source of that energy.
4. Identify the intermediate source, if there is one.
5. Identify the primary source.

(See example on page 19.)

Complete an example or two with the students. Have the students do another example independently. Discuss their responses, clarifying concepts where necessary. Have students do additional examples independently.

When the charts are completed, discuss with the students the amount of time required to renew the various sources they have identified.

Evaluation: Review the charts with students. Conclude that the primary source of energy for food and fuel is solar energy and that the primary source for most electricity is solar.

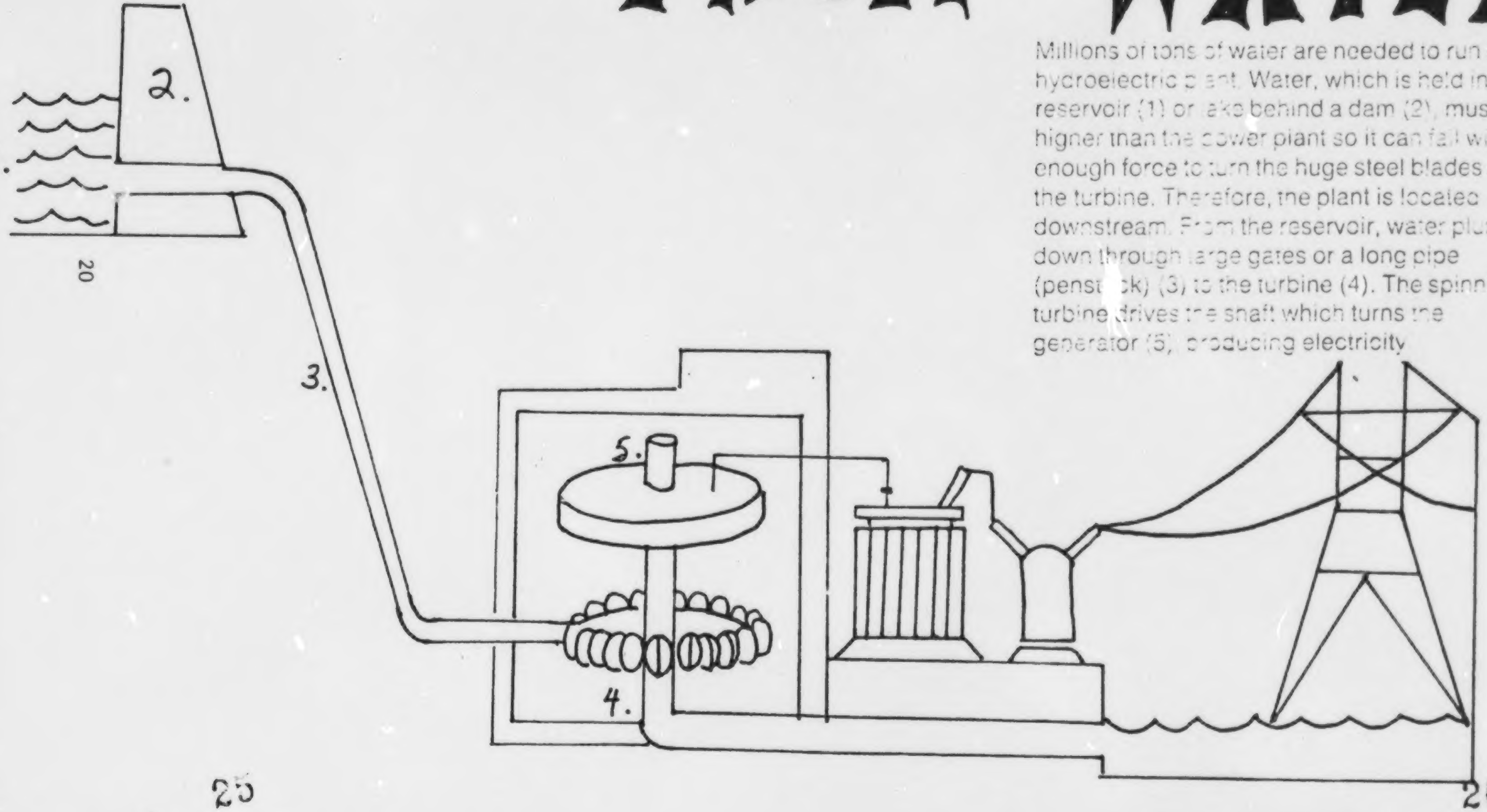
If your students need further experience with these concepts, see ENERGY/ENVIRONMENT, Grade 4, for activities.

ENERGY

Phenomenon	Observed Effect	Energy Form	Immediate Source	Intermediate Source(s)	Primary Source
burning candle	heat light	chemical	petroleum		sun
moving pinwheel	motion	mechanical (kinetic)	wind		convection by sun
exercising person	heat motion	chemical	eggs	chicken/chicken feed	sun
			milk	cows/grass	sun
			toast	flour/grains	sun
				milk/cows/grass	sun
				vegetable oil/corn	sun
				yeast/sugar/sugar cane	sun
			grapefruit	grapefruit tree	sun
incandescent bulb on	heat light	electrical	chemical combustion of fuel	animals/plants/green plants	sun
			or water power	lifted water	sun
			or nuclear		sun (fissionable materials

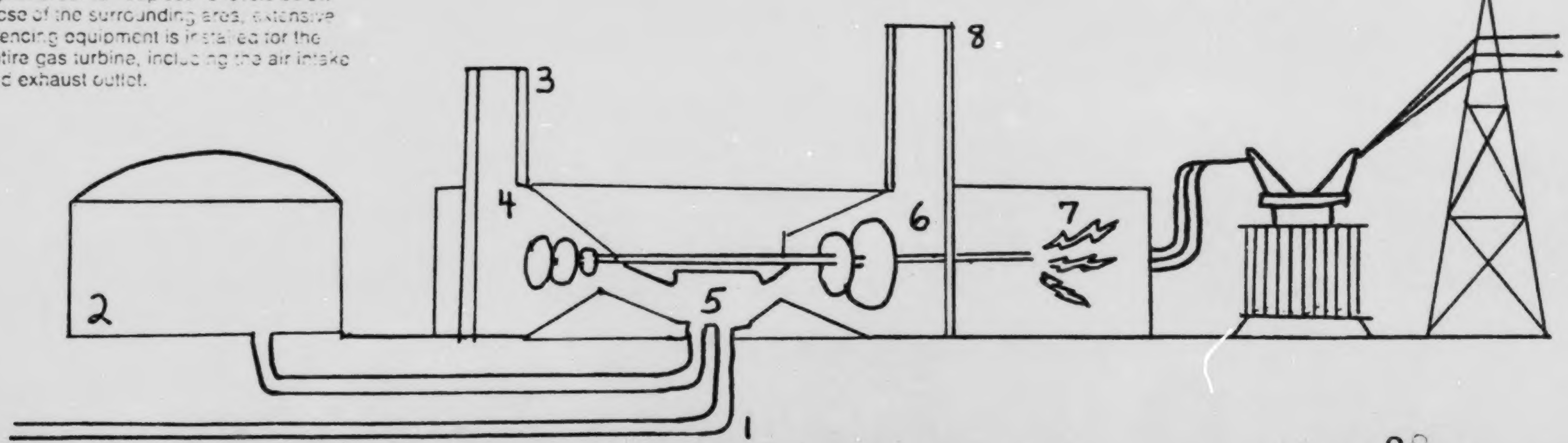
ELECTRICITY FROM WATER

Millions of tons of water are needed to run a hydroelectric plant. Water, which is held in a reservoir (1) or lake behind a dam (2), must be higher than the power plant so it can fall with enough force to turn the huge steel blades of the turbine. Therefore, the plant is located downstream. From the reservoir, water plunges down through large gates or a long pipe (penstock) (3) to the turbine (4). The spinning turbine drives the shaft which turns the generator (5), producing electricity



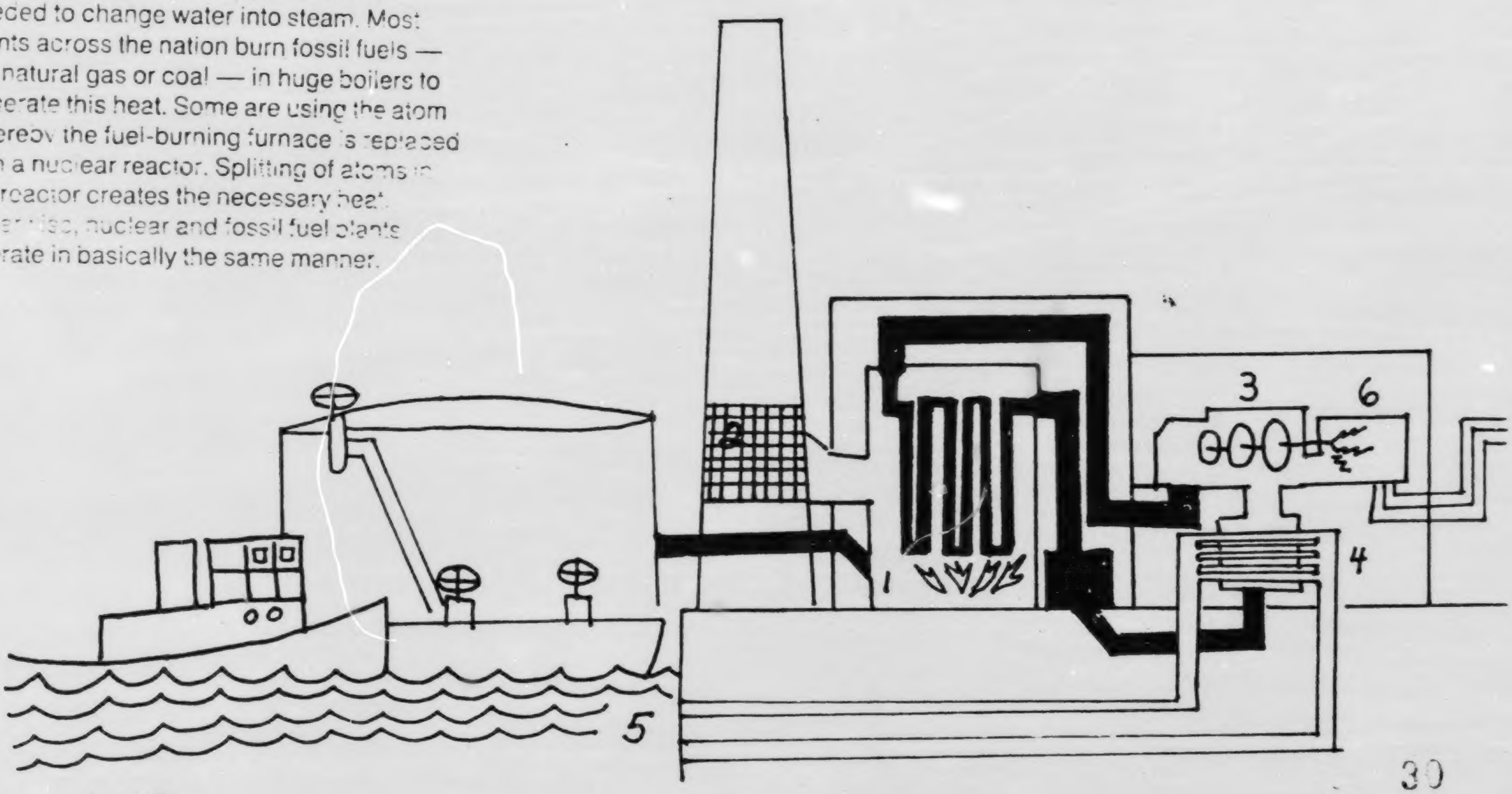
ELECTRICITY FROM GAS TURBINES

A gas turbine burns either natural gas supplied from a pipeline (1) (where available), or low-sulfur fuel, a type of oil which is delivered by truck or barge and stored in a tank (2). Air, drawn in from the outside (3), is compressed (4), and discharged into combustion chambers (5). Here, fuel is added, mixed with the air and burned. Burning process produces high-pressure combustion gases which flow to the turbine (6). Pressure of the gases rotates the turbine, which turns an electric generator (7). After passing through the turbine, gases are exhausted to the outside (8). In order to keep sound levels below those of the surrounding area, extensive silencing equipment is installed for the entire gas turbine, including the air intake and exhaust outlet.

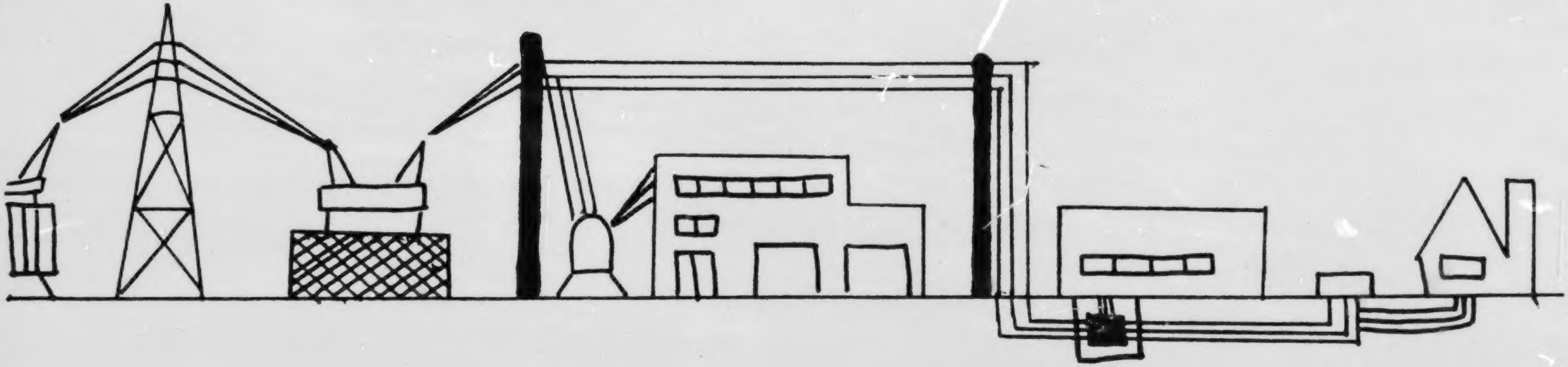


ELECTRICITY FROM FOSSIL FUELS

In steam-electric power plants, heat is needed to change water into steam. Most plants across the nation burn fossil fuels — oil, natural gas or coal — in huge boilers to generate this heat. Some are using the atom whereby the fuel-burning furnace is replaced with a nuclear reactor. Splitting of atoms in the reactor creates the necessary heat. Otherwise, nuclear and fossil fuel plants operate in basically the same manner.



Fuel is delivered to plant and stored in yard. Oil or finely powdered (pulverized) coal is blown into the boiler (1) where it burns, giving off intense heat. Water, circulating through miles of tubing in the boiler, absorbs heat from the fire and changes into steam. Ash resulting from the fuel burning in high-pressure boilers is removed from the stack gases by dust collectors (precipitators) (2). This permits clean gases to be released to the atmosphere, thereby reducing air pollution. Steam passes through the turbine (3) and into a condenser (4) where it is cooled and changed back into water as it flows over thousands of tubes. Water is then returned to boiler for reuse in the system. Water to condense steam is drawn from the body of water on which the plant is located (5), pumped through tubes in the condenser and returned to its original source. The turbine consists of a number of rows of blades which, much like spokes on a wheel, stem out from a shaft at the center. Steam acting against these blades, like wind on a windmill, causes the shaft to spin; its exact speed is controlled by a governor. Shaft turns the generator (6) which has two parts: a stationary part, coils of wire (stator); a rotating part, a magnet (rotor). Magnet rotates inside coils of wire. As the magnetic field moves at high speed past the coils of wire, alternating current is generated. Electricity then goes to a substation (7) outside the plant where transformers raise the voltage (electrical pressure) high enough to send the power many miles. Large cables (transmission lines) (8) suspended on steel poles or towers carry the current to substations (9). Here the voltage is lowered and electricity is fed into a distribution system (10). Smaller transformers provide proper voltages for industries, stores, homes and farms. After it reaches the customer, electricity goes through a meter which measures the amount being used.



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R E F I N E P E R T C N O I T S U B M O C
A Q F D R P M E U P L A M R E H T O E G P
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R I T H Y S T H G I L N A M A C E B R T I
W O R K D Y B N D S T E A T H Y L T M R R
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R E N E W A B L E M K E I K I N E T I C D
T I N G L T S O I E C A L O R I E S F V Y
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D O M I T H U K I C O N S E R V A T I O N
N T I P O T E N T I A L E L L E N I N G H
N D I N I N C A N D E S C E N T D E O L A
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1. ASPHALT
2. ENERGY
3. PETROLEUM
4. HEAT
5. LIGHT
6. FISSION
7. FUSION
8. NUCLEAR
9. MECHANICAL
10. CHEMICAL
11. CALORIES
12. COAL
13. PETROCHEMICAL
14. POTENTIAL
15. KINETIC
16. REACTOR
17. RENEWABLE
18. NATURAL GAS
19. PHOTOSYNTHESIS
20. KILOWATT
21. SUNLIGHT
22. SOLAR
23. THERM
24. FOSSIL
25. TON
26. FUEL
27. REFINE
28. CONSERVATION
29. TRANSFER
30. COMBUSTION
31. ELECTRICITY
32. FORCE
33. THERMAL
34. WORK
35. HYDROELECTRIC
36. GEOTHERMAL
37. RESOURCE
38. INCANDESCENT

OBJECTIVE 2: *Students will explain energy epochs.*

ACTIVITY 3

Learning: People have used different fuels to produce needed energy throughout history.

Materials: "Energy Epochs" chart (Appendix A-6), "Research Guide" activity sheet (Appendix A-7), encyclopedias.

Teacher Information: This is the first in a series of five activities designed to help students understand the sequence in the development of energy sources. If young people are to understand the ever increasing consumption of oil and natural gas, they need the background provided in these activities.

Procedure: Tell students this story:

> In 1901 Greatgrandma and Greatgrandpa Adler came to California by train. The train engine burned coal to produce the steam that drove it. They settled in San Diego in a large house near 14th and "C" Streets. The house was heated by wood and lighted by oil lamps. Greatgrandma Adler cooked on a wood-burning stove and did the laundry in a big tub on the back porch. She hung the laundry on a line that Greatgrandpa had put up in the back yard. They had a garden that provided most of their fresh vegetables in the summer, and Greatgrandma canned vegetables for winter needs. She put the butter that she churned in an icebox in the kitchen that kept food cool as long as the iceman came regularly and put a large block of ice in it. Greatgrandpa Adler walked to work at 5th and Broadway. It was just over a mile, and he thought nothing of it--the exercise kept him fit. The Adler children walked to school, and on Saturday the entire family walked to synagogue.

Ask students to recall the sources of energy that were mentioned in this story. List them on the board (coal, wood, oil). Point out the absence of gasoline or natural gas. Explain that this story took place in one "energy epoch" and we now live in another. There have been many epochs in the history of energy.

Show the "Energy Epochs" chart and explain that this chart shows our use of fuels from about 1850 to the present with a question for the future. Even though this is only a small portion of time, it shows that we were relying mostly on wood in the mid-1800's and using relatively little. By the turn of the century, we had converted mostly to coal, and the increase in consumption is apparent. By the 1920's oil was being used more and more with natural gas becoming a major source of energy by the early 40's. The first nuclear generating plant was opened in Pennsylvania in 1957 to usher in perhaps another epoch. However, at the present time we are depending primarily on oil and natural gas.

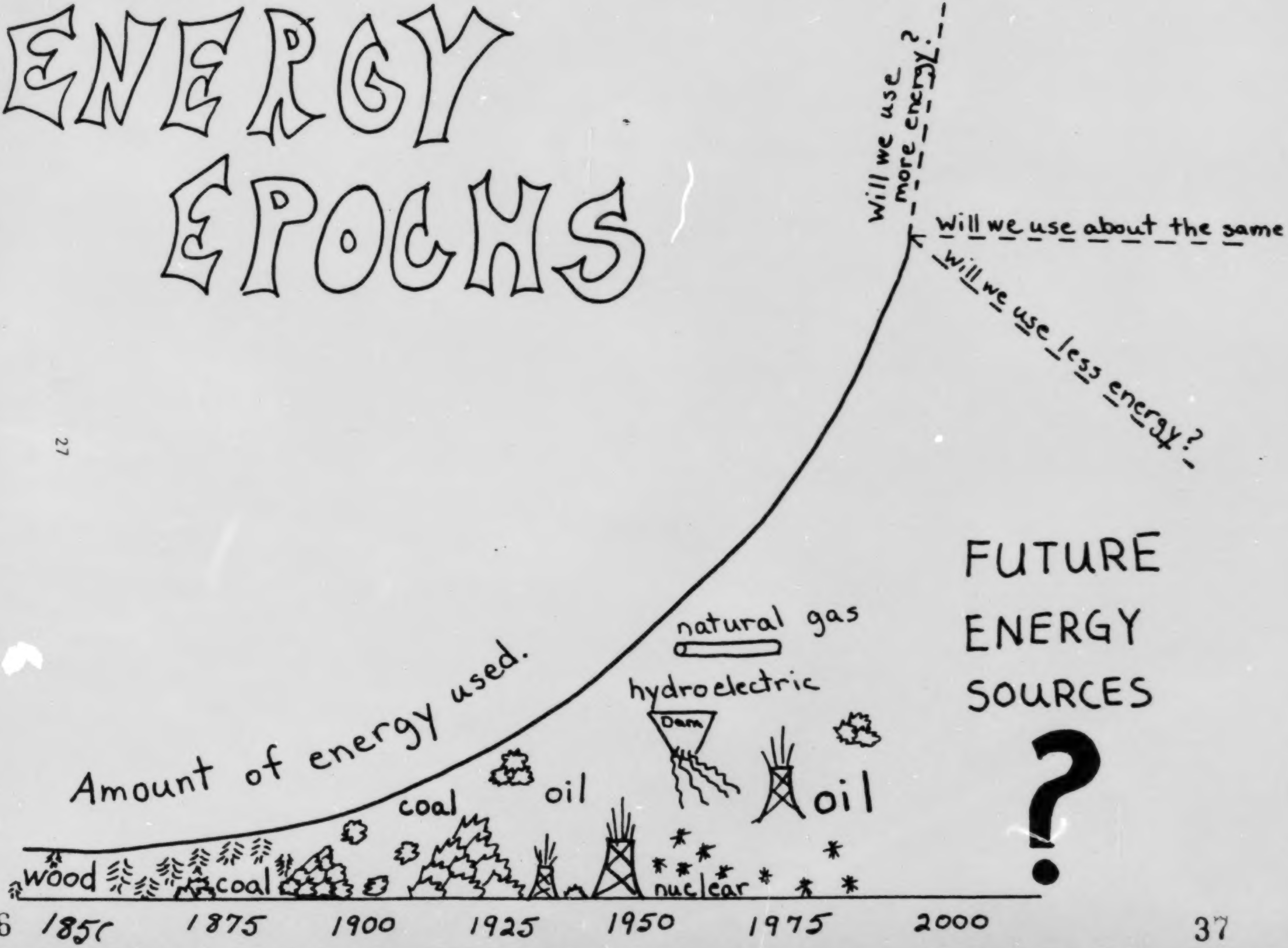
In order to complete the energy epoch chart (before Greatgrandma and Greatgrandpa Adler's time), assign small groups of students one of these as a research project:

Muscle Power (man and animal) as a Source of Energy
Water as a Source of Energy
Wind as a Source of Energy
Steam as a Source of Energy
Coal as a Source of Energy

After each group reports back to the class on their research project, make an Energy Time Line to reflect the many energy epochs in the history of mankind. Illustrate each epoch.

Evaluation: Have students determine the reasons for the transition from one energy epoch to another.

ENERGY EPOCHS



RESEARCH GUIDE

1. Topic for research: ______________________________

2. Use the index of books to find page numbers that will give you information. Write them:

   ____

3. Read the pages in the first source. Summarize each page.

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

4. Repeat for each source.

   ____

   ____

   ____

   ____

   ____

5. What is the main idea of what you read? ______________________________

   ____

   ____

   ____

6. If there is a picture or chart that will help explain the information, draw it on a piece of large paper.

7. Think of how you can present your ideas to the class so they will understand what you found.

ACTIVITY 4

Learning: Inventions have opened the door to new epochs in the history of energy.

Materials: Encyclopedias, other classroom resources, "Research Guide" activity sheet (Appendix A-7)

Procedure: Have small groups of students research the following inventions:

Railroad Locomotive
Steamboat
Reaper
Telegraph
Automobile
Airplane
Synthetics

As students report to class, have them indicate the impact of that particular invention on energy consumption.

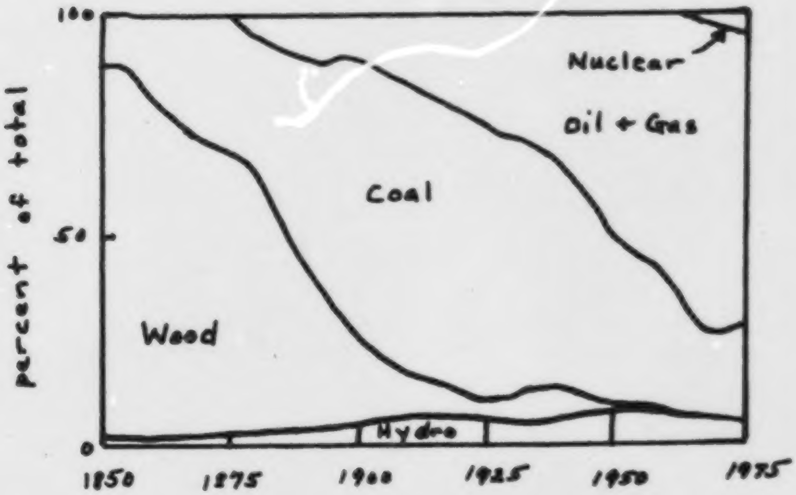
Evaluation: Determine the position of each invention on the Energy Time Line (see Activity 3).

ACTIVITY 5

Learning: Each energy epoch has had advantages and disadvantages.

Procedure:

Historical U.S. Energy Mix



Referring to the energy epoch in which coal was the main energy source, discuss the breakthrough the use of coal was for this country. It provided for many luxuries. It also caused much pollution. Then we moved into the oil epoch. Oil and natural gas are cleaner and easier to use. Why, then, are there problems?

Have students find the meaning of "technology" in the dictionary. Discuss how technology has contributed to environmental problems of each epoch.

Evaluation: Have students name some advantages of the energy epoch that we are in now. List these on the board under "Advantages." Do the same for "Disadvantages."

Repeat the process for each of the epochs on the Energy Time Line.

EPOCH	ADVANTAGES	DISADVANTAGES
Oil		
Gas		
Coal		
Wood		
Wind		
Water		

Extended Activity:

Preprint the name of each energy epoch on a chart or poster. Divide the children into groups to represent each energy epoch, so that approximately the same number are in each group. Have the children discuss within their group the ways in which people used the energy sources available during their assigned epoch.

Have one child at a time draw a picture representing the way people used the energy available to them on the preprinted poster. Let them continue until they run out of ideas or out of space on the poster. Hang the posters up in chronological order. Let children from the prehistoric group state why their source of energy was good. Then have each group, successively, explain why their energy source was better. From this discussion children should gain an understanding of why each succeeding epoch became the viable one.

ACTIVITY 6

Learning: People's use of the environment has changed through energy epochs.

Materials: "Research Guide" (Appendix A-7)

Procedure: Explain that when people first appeared on the earth they were hunters and gatherers. In this role they had very little effect on the ecological balance. Then came one of the most momentous revolutions in the world--the Agricultural Revolution. After people domesticated plants and animals, they began to have a real impact on their environment. Settlements became permanent, and the earth's population began to increase. As people developed more and better tools, they became builders capable of reshaping and altering their surroundings. Finally, people made their bid to control the earth by becoming manufacturers. They converted the raw materials of the earth into the artificial products they needed and desired.

Have a small group of students research the topic of "How People Have Used the Environment through Energy Epochs." (The "Research Guide," Appendix A-7, may help them.)

Evaluation: After the research has been done, have the information presented in correlation with the Energy Time Line.

OBJECTIVE 3: *Students will identify some present environmental concerns that are energy-related.*

ACTIVITY 7

Learning: All people share our thin layer of life-giving air.

Materials: "The World's Air" activity sheet (Appendix A-8)

Teacher Information: People seldom think about the thin, delicate life-giving layer that surrounds the earth called air. We need to help young people understand more accurately how air affects people's lives and how they, in turn, affect the air they breathe.

We must help students realize that what affects air in one part of earth can affect the entire world's air.

Procedure: Distribute the activity sheet, "The World's Air," Appendix A-8. Make sure students understand that air is a life-giving, delicate and relatively thin layer that belongs to everyone on our planet.

Have students read the two paragraphs and answer the questions on the activity sheet.

Evaluation: Have students share their answers to question Number 7 on the activity sheet. Discuss the similarities and differences in their answers. List the answers to Number 8 on the board, then go through the list and have students determine how each of these uses would affect our air.

THE WORLD'S AIR

The air that you breathe keeps you alive. It does not belong to you. You only use it for a time and it then moves on to keep someone else alive. The air in our world belongs to all living things that need it to stay alive. We do not get "new" air. Instead, we use the same air over and over.

Air is always moving. It moves indoors and outdoors. Air movements, called air currents, move air from one place to another. The air that we use in our city today will be the air in another city tomorrow.

Answer these questions:

1. Give two examples that tell you that air moves.

   ____

   ____

2. Define *pollution*. (Use a dictionary.)

   ____

   ____

3. Tell in your own words what air pollution would be.

   ____

   ____

4. If a ship 10 miles out to sea is polluting the air, how could that affect the air you breathe?

   ____

   ____

5. Why would the people of a city be concerned with the smoke from a factory 20 miles away?

   ____

   ____

6. How does traffic affect our air?

   ____

   ____

7. Why should all people in our world be concerned with our air?

____

____

8. Name three ways you have used our air today.

____

____

____

ACTIVITY 8

Learning: People have discovered new forms of energy throughout time. These discoveries have influenced methods of transportation.

Materials: Mural paper, yellow chalk, paints, brushes, containers of water

Teacher Information: Students must have been exposed to the historical development of energy before beginning this project. Discuss with the students the forms of transportation that were used during each of these periods. Also discuss with them forms of transportation that they would invent to use the newer sources of energy. List all of these on the chalkboard.

Procedure: Divide the mural into periods of the development of each energy source. Have students use the chalk to draw the form of transportation used by human beings--from walking and riding on animals to nuclear-powered ships, concluding with their own inventions.

Assign three or four children at a time to paint the mural. Remind them to work from top to bottom and from background to foreground. Give each child an opportunity to do some of the painting. Use the mural to help children understand how our transportation methods are related to the available energy sources.

Evaluation: Have students explain the mural to other classes.

ACTIVITY 9

Learning: Air pollution has an economic and a health cost.

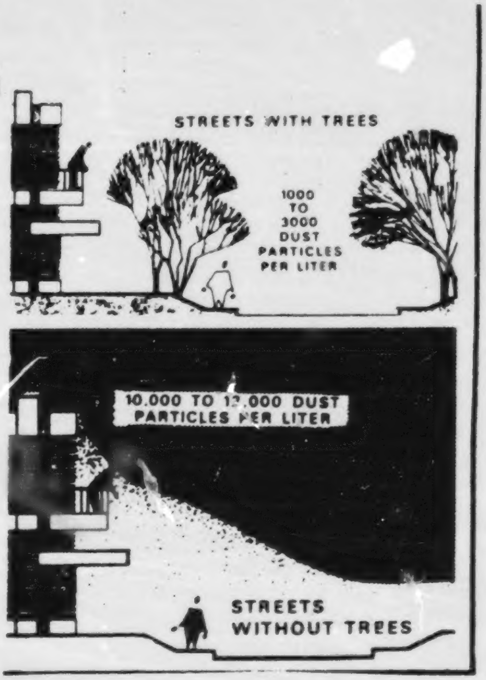
Materials: "Dollar Cost of Air Pollution," transparency master (Appendix A-9); "Health Cost of Air Pollution," transparency master (Appendix A-10); "Streets with Trees," transparency master (Appendix A-11).

Teacher Information: Air pollution is a serious problem in many places and a growing concern in many more. Students need to become aware of the costs of air pollution--to our health as well as economically.

Procedure: Explain to students that air pollution is a growing concern, because it is becoming more and more costly to more and more people. Tell them that it is costing us all in dollars.

Using the "Dollar Cost of Air Pollution" transparency, explain (write these figures on the chalkboard): It is estimated that it annually costs the nation

$7 billion in medical care
$25 billion in lost wages
$500 million in damaged crops and livestock
$200 million in decreased property value
$40 per year to each American in extra maintenance costs


STREETS WITH TREES
1000 TO 3000 DUST PARTICLES PER LITER
10.000 TO 12.000 DUST PARTICLES PER LITER
STREETS WITHOUT TREES

Point out that these figures represent the nation, but that each one affects us individually, either directly or indirectly. Discuss which effects are direct, which are indirect.

Using the "Health Cost of Air Pollution" transparency, explain that the dollar cost is not the only way we are paying the high price of air pollution.

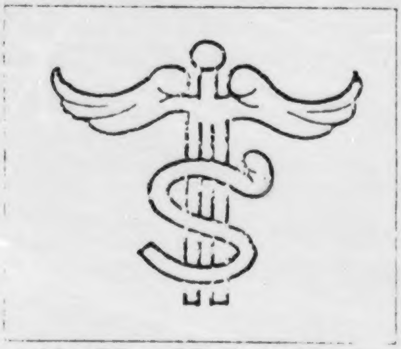
Explain that this chart compares the number of cases of emphysema (a lung disease) at different age levels in two cities. One city, St. Louis (locate on map), has many factories and a lot of pollution. The other city, Winnepeg (locate on map), has little industry and is more pollution-free.

Ask:

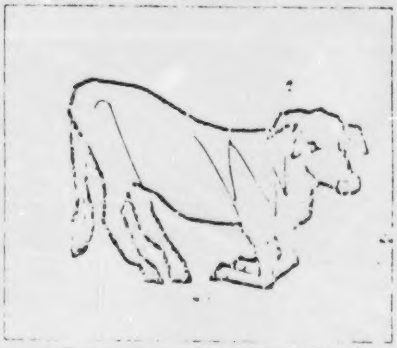
> Which city has the highest incidence of emphysema? The lowest? What age group is affected most in both cities? Why do you think this would be true? Why do you think more people of all ages are suffering from emphysema in St. Louis than in Winnepeg?

Evaluation: Show the transparency, "Streets with Trees," without explanation. Have students use the two charts, as well as the data from the two previous transparencies, to write a paragraph on "Ten Dollars for a Tree Is a Small Price to Pay."

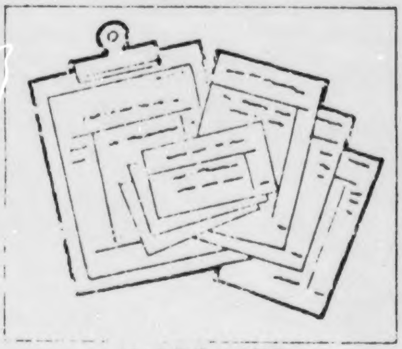
Dollar Cost of Air Pollution



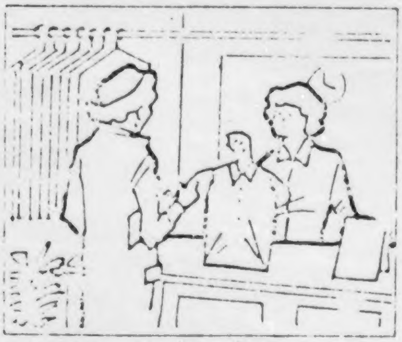
HIGHER MEDICAL COSTS



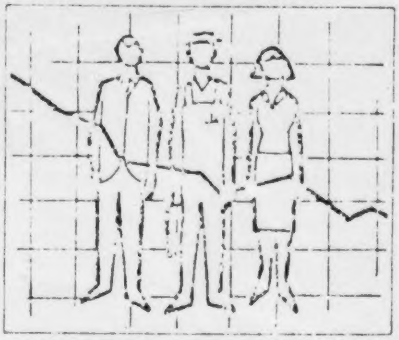
LOSS OF LIVESTOCK



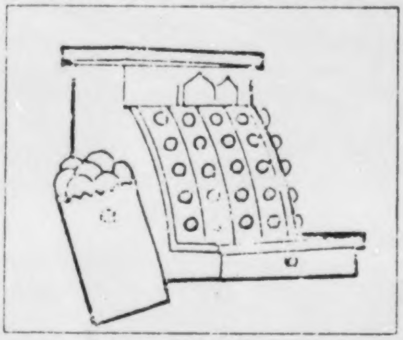
INCREASED MAINTENANCE COSTS



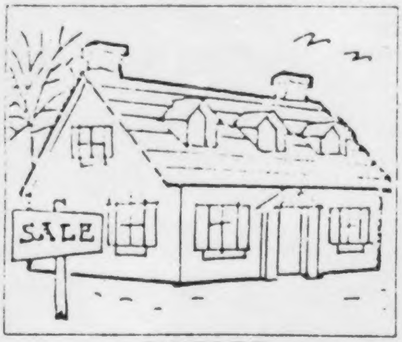
HIGHER CLEANING COSTS



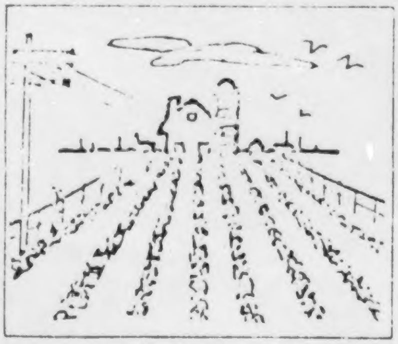
GREATER ABSENTEEISM



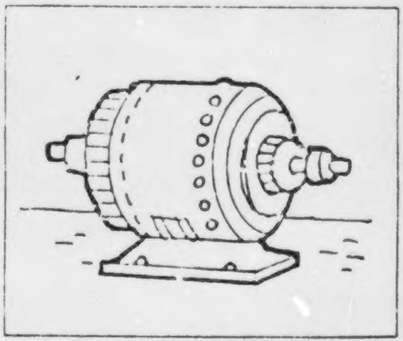
HIGHER FOOD BILLS



LOWERED REAL ESTATE VALUES

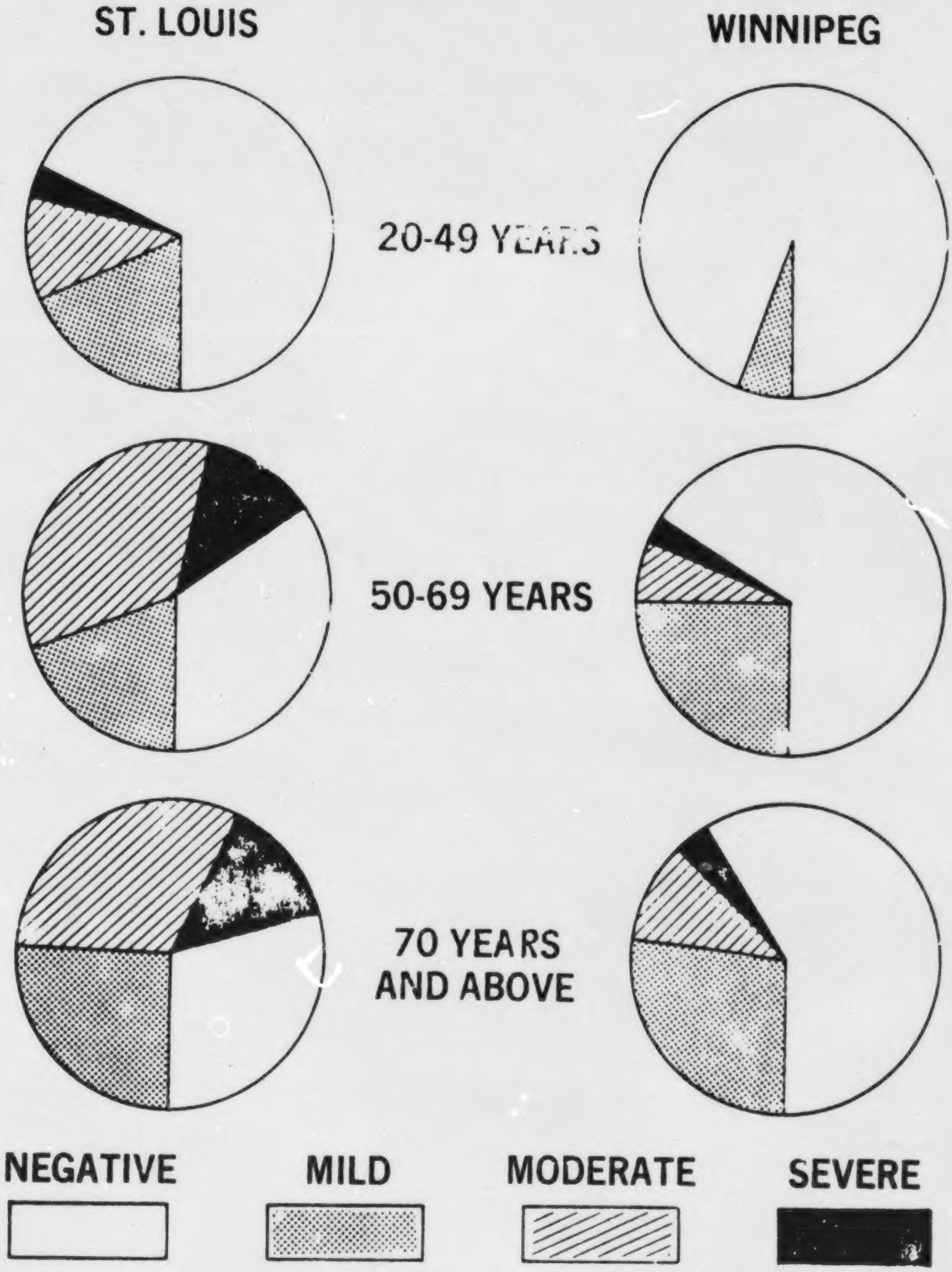


REDUCED OR DESTROYED CROPS

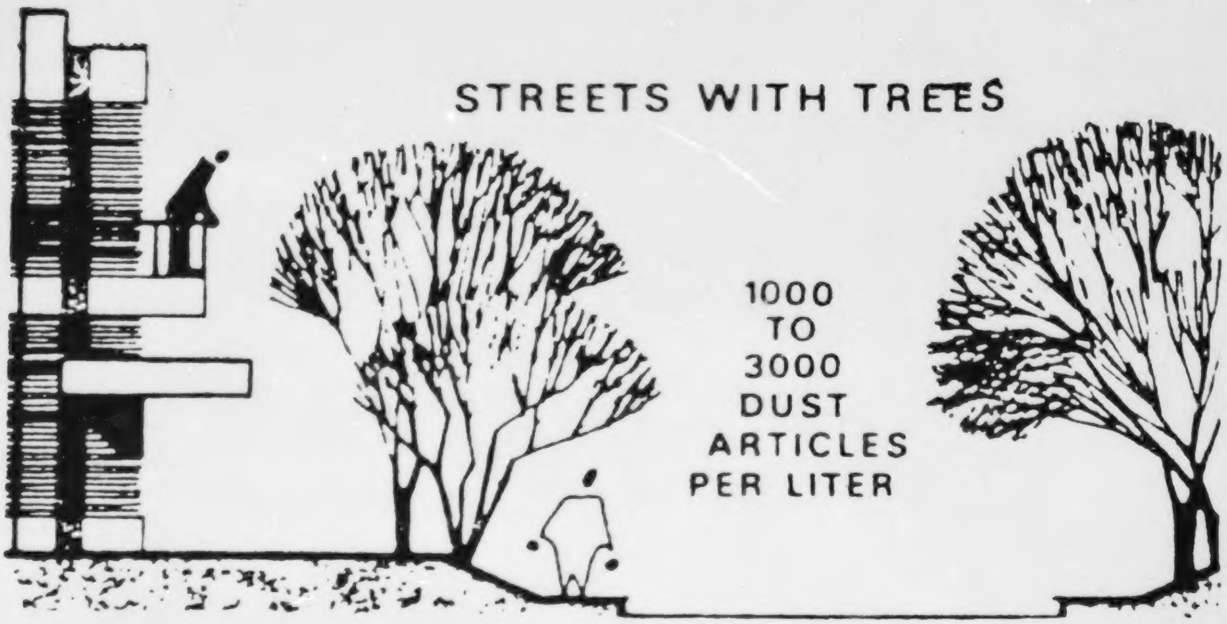


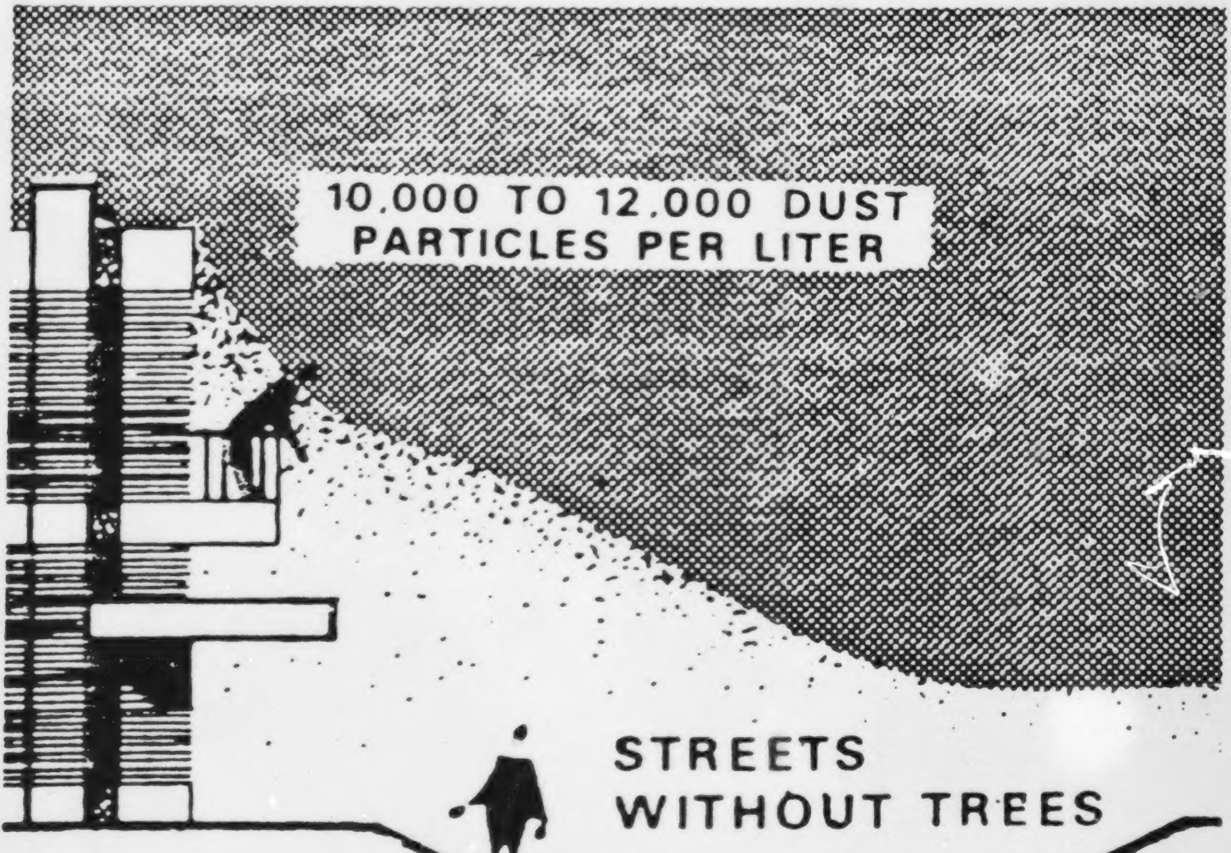
COSTLIER EQUIPMENT

COURTE[illegible] NATIONAL TUBERCU[illegible] AND RESPIRATORY DISEASE ASSOCIAT



COURTESY: NATIONAL TUBERCULOSIS AND RESPIRATORY DISEASE ASSOCIATION


STREETS WITH TREES
1000
TO
3000
DUST
ARTICLES
PER LITER


10,000 TO 12,000 DUST
PARTICLES PER LITER
STREETS
WITHOUT TREES

ACTIVITY 10

Learning: Air pollution varies on a daily basis.

Materials: Camera, slides, film, map of school area or similar area

Teacher Information: The amount of air pollution in a given area depends upon three major factors: (1) total amount of pollutants entering atmosphere in the area, (2) topography, and (3) weather patterns.

Concentrated areas of heavy industry and dense population frequently are prone to higher pollutant levels. The weather patterns in Los Angeles and San Diego both have onshore winds coming in from the ocean. In both cases the winds push the pollutants toward mountain ranges. Los Angeles' mountain ranges form barriers to the north and east of the valley. To the south the smaller ranges also tend to concentrate the pollutants in an area known as the Los Angeles Basin. The San Diego area finds a concentration of pollutants in El Cajon Valley and Alpine with the prevailing winds onshore, pushing the pollutants against the mountains.

The sources of pollution include:

1. Autos, buses, trucks, motorcycles--vehicles which burn fuel.
2. Stationary sources such as power plants, factories, gasoline stations (gas vapor emission), dry cleaners, wet paint. (All the fumes from the drying paints, especially oil base paints, have to go into the air.)
3. Dust from tires, brakes, dirt roads, forest fires.

All these elements enter the atmosphere, where some of these pollutants react with the air and sunlight, creating photochemical smog. Other reactions take place, giving off other forms of smog. Not all the pollutants are visible. The brown smog is caused by the oxides of nitrogen.

While it is true that the total number of people in a given area has an effect (indirect) on the pollution levels, people per se aren't the major causes. What they do and how they use their resources, mindful or not of the pollution they create, is what contributes to the total amount of pollutants.

Procedure: Make a map of the school area, or obtain a professionally prepared map. Take your class outside and ask questions such as the following:

1. What is the farthest thing you can see now?
2. How far can you see today?
3. Why can't we see as far on some days as on other days?

Have pupils make daily observations at the same time during the school day. Select the same landmarks as reference points. Make a simple chart to record observations. Compare groups' charts for accuracy.

Date	10:00	12:00	2:30
Sept. 20	Freeway--4 miles	Trees on street--2 miles	Building--7 miles
Visibility	visible __ not visible __	visible __ not visible __	visible __ not visible __

If a camera is available, pupils may take pictures at the times indicated on the chart. Use pictures to record changes in visibility conditions. Be sure to take the pictures from the same spot and in the same direction each time.

Evaluation: Have children list some of the causes of the air pollution they have observed. Discuss some ways to lessen this pollution.

Resources: Map Centre has San Diego maps. Federal airports have recorded telephone messages giving visibility on an hourly basis.

ACTIVITY 11

Learning: Considerable air pollution comes from our many uses of energy.

Materials: "The Great Gearloose Creation" activity sheet (Appendix A-12)

Teacher Information: One ton of pollutants per American per year is added to natural air pollution in the United States alone. The larger particles--mostly dust, ash, smoke, and fumes--settle down quickly. The smallest ones, called aerosols, remain suspended much longer. Like gases, they drift with the wind to contaminate earth's remotest places.

Procedure: Read "People and the Air" (below) to the class. Quickly have students give you one word to describe how the passage makes them feel.

PEOPLE AND THE AIR*

> Long ago, the air carried only natural things: moisture that turned into rain, dust blown up by the wind.
>
> Now the air around us is sometimes thick with pollution. Polluted air can make people sick. Polluted air can kill plants. Polluted air hangs over many cities.
>
> The needs and wants of people often lead to pollution. People need cars. In this country some families have two cars, or even three. Every car that moves pollutes the air when it burns gasoline and sends fumes out the exhaust.
>
> People need clean air. People can spoil the air, or they can work to save it.

---

*Adapted from *Save the Earth: An Ecology Handbook for Kids* by Claire A. Nivola.

Discuss these questions:

1. What are some causes of air pollution?
2. How does the natural movement of air affect air pollution?
3. What are the costs of pollution?
4. Who pays for it?
5. How does air pollution affect humans and other living things?
6. How could automobile exhaust in San Diego affect trees 40 miles away?
7. How does our need for electricity cause air pollution?

8. How does our need for transportation cause air pollution?
9. What is the real cost of air pollution?
10. Who pays for stopping pollution?

Stress that not only do Number 6-8 cause pollution, they are our big energy users.

Evaluation: Have students name some causes of air pollution. Involve the class in brainstorming examples of air pollution (using what they have read about, heard about, and seen). List these examples on the chalkboard.

Extended Activity: Some students may enjoy the creative challenge of the activity sheet, "The Great Gearloose Creation" (Appendix A-12), in which they must design a pollution-free form of transportation.

THE GREAT GEARLOOSE CREATION

If you have an imagination, you will have fun with this. Just let your creativity run wild!

Imagine that you are Gotta Gearloose, a scientist and inventor who lives in the town of Fairview. Many citizens in your town have complained to the mayor that the air in Fairview is not as clean as it used to be. Because he is running for reelection, the mayor, Mr. Win D. Bag, has decided to do something about the problem (immediately, if not sooner!). He has decided to ban all automobiles as a form of transportation. He has asked you, Gotta Gearloose (world-famous inventor), to design a new form of transportation that will not pollute the air. Your plan is due at the end of this period. (This is a rush order--election is next week!)

Think about these questions before you begin:

1. What kind of energy will your new form of transportation use?
2. Will it go on land, in the air, on water, underground, or all four?
3. How many people will it carry?
4. How big will it be (size-wise)?
5. What will it look like?
6. How fast will it go?
7. How safe is it?
8. How often will it need to be repaired?
9. What will you name your creation?

Draw a picture of your pollution-free form of transportation and write a paragraph describing it.

ACTIVITY 12

Learning: Noise is becoming a dangerous and disturbing environmental pollutant.

Materials: "Noise Levels in Decibels" (Appendix A-13), "Recreational Noise" activity sheet (Appendix A-14), "Noise Sources" (Appendix A-15), "Noise Level of Home Appliances" (Appendix A-16), "Hazardous Noise" (Appendix A-17).

Teacher Information: Noise, commonly defined as "unwanted sound," has been with us since antiquity. The Romans enacted the first probationary noise law when chariot movements on Roman streets were prohibited by popular decree. A court decision concerning noise abatement occurred in England in the 13th century. Today, citizen complaints have virtually outlawed the supersonic transport. Antinoise ordinances are prevalent in many communities today.

Another aspect of noise pollution that needs to be recognized is that in our technological society it is directly related to energy consumption.

For your information, two charts showing noise levels of different machines are in the Appendix (A-16 and A-17). You may wish to use them with this lesson.

The unit of measure for recording the volume and intensity of sound is called a decibel (db with no period).

Procedure: Have students close their eyes for a full minute and listen for all the sounds they can hear.

Discuss the concept of noise as being a form of pollution. Point out that people get so used to noise that they don't really hear it, but that it is affecting them. Noise can cause fatigue and irritability as well as cause people to make more mistakes.

Present the chart "Noise Levels in Decibels" (Appendix A-13).

Discuss the physical implications of excessively loud noise and the psychological implications of prolonged noise to an individual.

Distribute "Recreational Noise" activity sheet (Appendix A-14). (Be sure students can see the "Noise Levels in Decibels." They will need the data for the activity sheet.)

Evaluation: Discuss the activity sheet and allow students an opportunity to discuss recreational vehicles as contributors to noise pollution. This will be a value-laden discussion, so be sure each person has the opportunity to express his/her own views in an atmosphere of respect for that right.

Finally, ask, "How are noise pollution and the use of energy related?" Lead students to see the direct relationship. Ask for specific examples.

Ask, "Do you think there should be a law prohibiting the use of recreational vehicles that contribute to noise pollution?" Allow students to express personal feelings without being judged by other class members. After several volunteers have reacted to the question, ask, "Why do you think there is disagreement on this question?" Discuss the implications to the larger society by asking, "Who should decide whether or not there will be laws governing the use of recreational vehicles that contribute to noise pollution?"

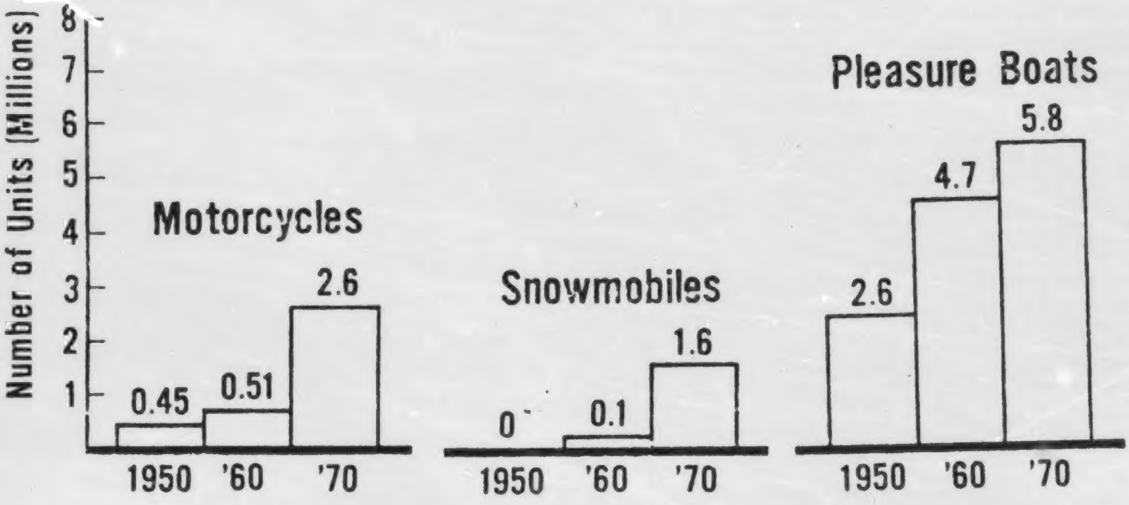
NOISE LEVELS IN DECIBELS:

	200	Noise Weapon
	190	
LETHAL LEVEL	180	
	170	
	160	
	150	Jet Aircraft at 200 feet
	140	
	130	Pneumatic Riveter; Air Raid Siren
THRESHOLD OF PAIN (one trillion times greater than least audible sound)	120	
	110	Rock Music with Amplifiers (4 to 6 feet away); Power Mower
	100	Food Blender (2 to 4 feet away) Motorcycle Subway Train
	90	Sports Car; Heavy Truck
DANGER LEVEL	80	
	70	Busy Street
	60	Normal Conservation
	50	Quiet Street, Average Urban Interior
	40	Quiet Room, Residential Area at Night
	30	Tick of Watch (at 2 feet)
	20	Whisper
	10	Leaves Rustling in Wind
THRESHOLD OF HEARING	0	

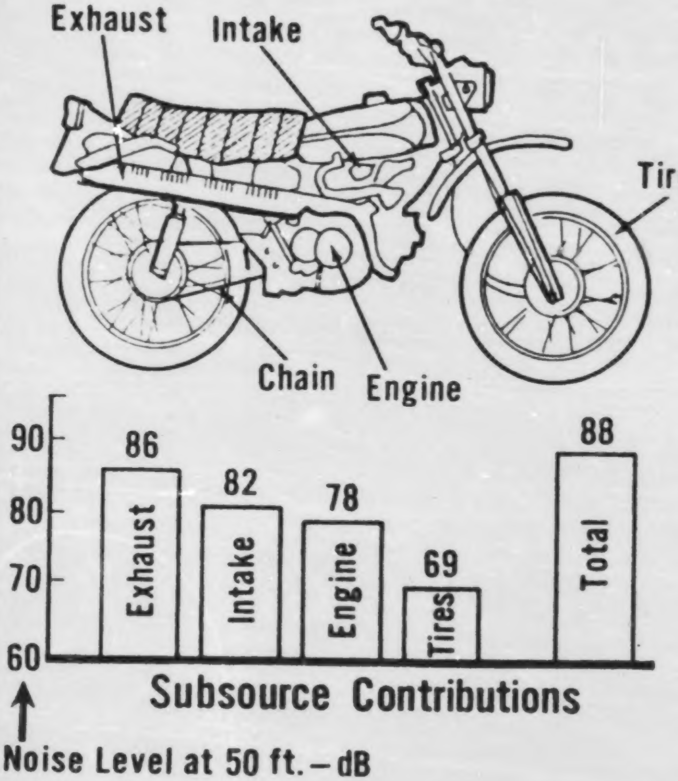
RECREATIONAL NOISE

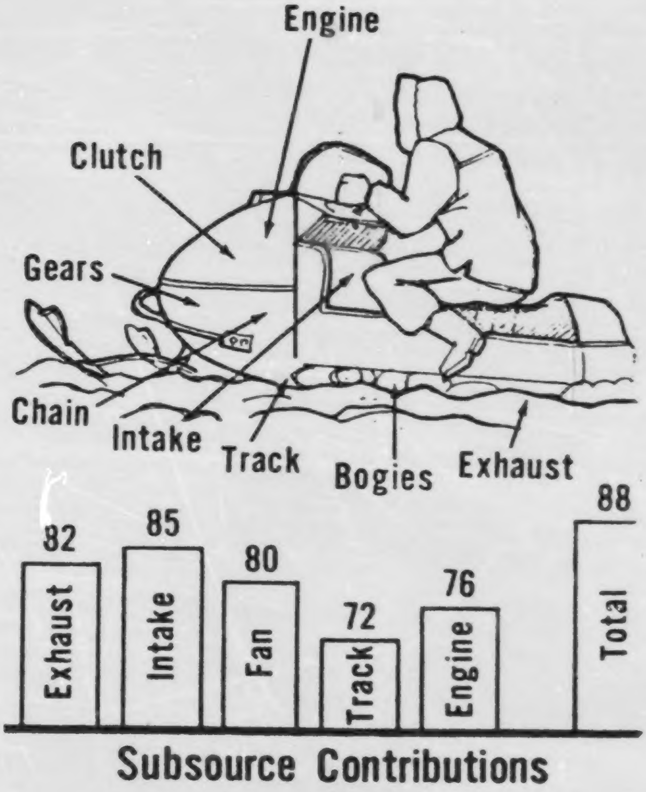
The use of recreational vehicles has grown in the past 10 years. Improved design is producing lower noise levels. Use these charts to answer the questions.

GROWTH OF RECREATION VEHICLES



NOISE SOURCES:





RECREATIONAL NOISE

1. What do the three bar graphs, "Growth of Recreational Vehicles," show?

2. What three recreational vehicles do the bar graphs represent?

3. Which of the three had the largest number in 1950?

4. Which had the least?

5. Which of the three had the largest number in 1970?

6. Which had the least?

7. Why do you think that is true?

8. Why do you think there is such an increase in the number of recreational vehicles since 1950?

9. Now look at the two bar graphs, "Noise Sources." What do they show?

10. What is the total noise level (in decibels) for the motorcycle?

11. What is its noisiest part?

12. What is the total noise level (in decibels) of the snowmobile?

13. What is its noisiest part?

14. Use the noise level chart and find where each of these recreational vehicles would be on that scale. Is it above the danger level?

15. What do you think should be done about these two vehicles that contribute to noise pollution?

Why?

NOISE LEVELS OF HOME APPLIANCES AND BUILDING EQUIPMENT

Noise Source	Level of Operator Exposure*	Level of Exposure** of People in Other Rooms
Refrigerator	40	32
Freezer	41	33
Humidifier	50	43
Floor Fan	51	44
Dehumidifier	52	45
Window Fan	54	47
Clothes Dryer	55	48
Air Conditioner	55	48
Clothes Washer	60	52
Stove Hood Exhaust Fan	61	53
Electric Toothbrush	62	42
Dishwasher	64	56
Electric Can Opener	64	56
Food Mixer	65	57
Hair Dryer	66	51
Vacuum Cleaner	67	60
Electric Knife	68	60
Electric Knife Sharpener	70	62
Sewing Machine	70	62
Food Blender	73	65
Electric Shaver	75	52
Electric Lawn Mower	75	55
Food Disposal (Grinder)	76	68
Electric Edger and Trimmer	81	61
Hedge Clippers	84	64
Home Shop Tools	85	75

*Termed "primary exposure"

**Termed "secondary exposure"

OPERATORS OR PASSENGERS EXPOSED TO HAZARDOUS NOISE

Source	Noise Level in dBA		Approximate Number of People Exposed (In Millions)
	Average	Maximum	
Snowmobiles	108	112	1.60
Chain Saws	100	110	2.50
Motorcycles	95	110	3.00
Motorboats (over 45 HP)	95	105	8.80
Light Utility Helicopters	94	100	0.05
General Aviation Aircraft	90	103	0.03
Commercial Propeller Aircraft	88	100	5.00
Internal Combustion Lawnmowers and other Noisy Lawn Care Equipment	87	95	23.00
Trucks (Personal Use)	85	100	5.00
Home Shop Tools	85	98	13.00
Highway Buses	82	90	2.00
Subways	80	93	2.15

ACTIVITY 13

Learning: Noise pollution affects people.

Materials: Encyclopedias, dictionary, magazines for pictures, 12" x 18" manila

Procedure: Divide the class into small groups. Have each group work on the assigned task by using the following as a guide:

Group I:

1. Define "pollution," "vibrations" and "decibels."
2. List at least 10 causes of noise pollution.
3. Make a list of noises that are harmful to the human ear.
4. Name three ways that too much noise is harmful to people.
5. Make a list of noises you hear when you sit quietly outside the classroom for five minutes.

Group II:

1. Interview three people outside the classroom to find out what kind of noises they like and don't like. Show the results of the interview on a chart:

Name of Person	Noises They Like	Noises They Don't Like

2. Draw a picture and write a paragraph that tells about your own favorite place to go for peace and quiet.

Group III:

Make a collage (collection of pictures from magazines) about noise pollution. One half of your paper should show causes of noise pollution and the other half places where you could find peace and quiet.

Group IV:

1. Write about how you feel when you are around unwanted noise. Express your feelings in a story, a poem, a song.
2. Write about how you feel when you are in a quiet place. Express your feelings in any way you like. It might be the second part of your first expression, or it may be another story, poem or song.

Evaluation: Have students complete this sentence: "The most harmful thing about noise is ______________."

ACTIVITY 14

Learning: Noise needs to be controlled.

Teacher Information: Noise levels in the United States are doubling every 10 years. This noise increase is producing at least partial deafness in over half the people in our country. While noise is not a new problem, there are now endless numbers of ways to generate it, countless additional people to intensify it, and fewer and fewer places to go to escape from it.

B-2 THE SAN DIEGO UNION Saturday, September 30, 1978

OTHELLO OVERPASS TO NEAR BALBOA

Noise Barrier Completed Along I-805

A $146,000 noise reduction barrier along Interstate 805, almost a mile in length, has just been completed, the California Department of Transportation said yesterday.

The concrete wall, 80 inches wide and ranging from two to eight feet high, runs from the Othello Street pedestrian overpass to near Balboa Avenue.

The structure was built to shield nearby residences and a city park from freeway noises, said Jim Larson,a CalTrans spokesman.

Noise reduction projects have been built throughout California since the mid-70s, Larson said.

In residential areas, they are confined to homes which were built prior to freeway construction, he explained. Today, noise reduction barriers are built into freeway construction plans to aleviate the problem, Larson said.

"If people call us and tell us about a noise problem or complain about it, we have devices which we use to measure sound in a particular area over an extended period," he said.

Anything above 70 decibels on the exterior of a home would qualify an area for noise reduction or abatement, he said. "As long as the noise does not exceed that limit (70 decibels) more than 10 percent of the time on exteriors, we feel we are within reasonable limits," he said.

Larson said the 70 decibels of freeway noise is equal to a shouting voice 12 feet away or a gasoline-powered lawn mower 100 feet away.

Heavy traffic at 300 feet measures about 60 decibels, while a rock band at its normal high level measures about 110 decibels, he added.

Larson said sound inside a large business office measures 60 decibels, while normal speech during a conversation measures 65 decibels.

"Generally, because of the lack of money, we are interested in areas where we can do the most good for the largest number of residents," he said. "We install noise barriers where the greatest benefit will accrue."

CalTrans usually contacts all residents in an area where complainsts are made, and goes along with whatever the majority wants, Larson added. He said that in some instances residents have objected to noise barriers — they do not want whatever view they have, or the air circulation, destroyed by a wall. "And some projects around the state have been dropped because people just didn't want them," he added.

For Fiscal 1979-80, CalTrans has $250,000 available for community noise projects and $273,000 available for school noise projects in the San Diego area, Larson said. School noise is abated, whether the school was built before or after the freeway was constructed, he said.

A school project now under study is Grossmont High School, adjacent to Interstate 8. Larson said CalTrans cannot construct a wall to reduce noise, so will do interior work such as air conditioning, possible elimination of windows. Earthern mounds were built into the Interstate 15 Escondido bypass to reduce noise and blend easily with the project, he said.

Procedure: Discuss with the class:

1. Noise has been a problem for a long time.
2. We now have many more ways of producing noise than in the past.
3. There are more people in the world than ever before to produce the noise.
4. There are not many places to go that are noise-free.

Have students think of things at home that make noise. List these on the chalkboard.

Have each student write the 20 noises that bother him/her most.

Evaluation: Conduct a class survey and find the 10 sounds that are most bothersome to students in the class.

Brainstorm ways these noises could be eliminated or lowered.

Tell students that noise has become such a problem to some people that there are "noise screens" on the market designed to mask disturbing noise. These products require energy to produce and energy to run them (they are electric) and the production of these machines contributes to air pollution.

Ask, "What is the effect on our lives of noise?"

Extended Activity: Have a small group of students write to a county official and get some information on noise pollution in San Diego County and what is being done about it. NOTE: Be sure the letters are written in good taste and reflect a genuine concern before mailing them.

ACTIVITY 15

Learning: In a global water system, water pollution in one part affects other parts.

Materials: "Our World's Water" activity sheet (Appendix A-18)

Teacher Information: The earth's surface is 70% water. This same water has been cycling from the world's bodies of water and from the earth's surface into the air and back again for millions of years. Like air, most people are relatively unaware of the omnipresence of water except when there is a lack of it. The activities on water and water pollution should enable students to see that in a global water system what happens to water in one part of the system affects other parts.

Procedure: Show students a picture of an ocean or a lake and have them give an adjective that comes to mind when they look at it. (List these on the chalkboard.)

Explain how ocean currents can cause water pollution in one part of the world ocean to pollute water in other parts.

Distribute the "Our World's Water" activity sheet. (See Appendix A-19 for format for Haiku and cinquain.)

Evaluation: Transfer the poems and free verse to construction paper. Center the writing and fill in the area around the verse with a water color picture. Have students share their work in a bulletin board display.

OUR WORLD'S WATER

Research these questions:

1. What is the earth's water system? ______________________________

____

2. Why is water so important to plants and animals alike?

____

____

3. How does water get into the air from bodies of water?

____

____

4. Name two ways it is returned to the bodies of water from the air.

____

5. What are ocean currents? ______________________________

____

How do they affect land? ______________________________

____

6. How would you explain oil appearing on San Diego beaches several days after a leak in an off-shore oil well near Santa Barbara?

____

____

7. React to this statement: "Water pollution is a worldwide problem."

____

____

____

What makes you feel that way? ______________________________

____

8. Write a poem (rhyming, unrhymed, Haiku, or cinquain) about water. Let it reflect how you feel about the earth's water system.

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OR

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OR

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ACTIVITY 16

Learning: Solving water pollution problems must involve all people.

Teacher Information: This activity should help students realize the seriousness of water pollution and that it is a global problem.

Discuss our need for water and that, although it is a renewable resource, there are more and more people on the earth to use it.

Put these headings on the chalkboard:

FARM HOME BUSINESS

Have students brainstorm ways each of these sources uses water. Then have students think of examples to illustrate how each source pollutes water.

Evaluation: These questions may be done orally or written, depending upon time and the abilities of the class. Either way, however, each child should "vote" (make a decision) on each question and *give reasons* for the response.

1. Should we spend money to keep water from becoming polluted?
2. Should we spend money to clean up water that is already polluted?
3. Should there be rules that each community must have a sewage treatment plant that really cleans up water?
4. Should producers pay for cleaning up all the pollution their business causes?
5. Should consumers who use the goods and services of businesses that cause pollution pay for cleaning up part of that pollution? How could this be done?
6. Who is responsible for keeping San Diego County's water clean and unpolluted?

ACTIVITY 17

Learning: We get energy sources from the land.

Materials: Energy Source Fact Sheets (Appendix B), available books on energy sources, encyclopedias, "Energy Sources Research Guide" (Appendix A-20)

Teacher Information: Land is part of a natural system (along with air and water) in which living things function. The following activities will involve students in discovering the *resources* this part of the system provides.

Procedure: Discuss the place of land in the natural system along with air and water. Discuss how living things are dependent on it just as they are on air and water. (Use examples of what land provides to sustain life on our planet.)

Discuss mineral resources that we take from the land. Focus on minerals that we use to produce energy. (coal and oil) Remind students that these mineral resources come from things like plants that were once living.

Have students recall sources of energy. List these on the chalkboard (sun, oil, coal, wood, water, nuclear, natural gas, wind, geothermal). Mark those that *come from the land*.

Assign each source that has been *marked* (that comes from the land) to a small group.

Have small groups use the "Energy Sources Research Guide" to research each source and then report back to the class. This sharing of information should be a good review of energy sources and help students focus on those energy sources that we take from the land, a part of our natural system.

Evaluation: Have each small group report to the class on the energy source they researched.

After each report, ask the class, "How does our use of that energy source affect the natural system?"

ENERGY SOURCES

RESEARCH GUIDE

1. What is your topic? ________________________________

2. Use the Energy Source Fact Sheets and encyclopedias to find information on this topic.

3. Use the information to answer these questions?

   Where is it found? ________________________________

   How is it taken from the ground? ________________________________

   How is it transported? ________________________________

   How is it used today? ________________________________

   How will it be used in the future? ________________________________

   What are its advantages? ________________________________

   What are its problems? ________________________________

4. Think of how you are going to present this material to the class. If charts, diagrams, or pictures will help, draw them on large paper so they can be seen.

5. Present your report to the class so they will know as much as possible about the source you researched.

ACTIVITY 18

Learning: Resources from the land provide energy. These resources are not evenly distributed in the United States.

Materials: "Present Energy Sources" activity sheet (Appendix A-21), "Fuels That Utilities Burn" chart (Appendix A-22), "Energy Sources" maps (Appendix A-23), "Coal Fields in the United States" transparency master (Appendix A-24), "Oil and Gas Fields in the United States" transparency master (Appendix A-25).

Teacher Information: It has been noted that in the next 10 years we will need as much electricity as all that has been produced since Thomas Edison invented the first successful incandescent lamp. It is predicted that by 1985 we will be using more than one million barrels of oil an hour in this country. The United States uses more energy than any country in the world.

This activity has students examining one of the present uses of fossil fuels--that of utilities. We, as consumers, are demanding more and more of the utilities' product--electricity. In order to produce that electricity, the utilities must burn fuel. The activity examines coal, oil, and natural gas as the sources most used by utilities. Students are asked to examine where those natural resources are located.

Procedure: Give students some background on why utilities use large amounts of fuel. Explain that, at the present time, utilities are using primarily fossil fuels (coal, oil, and natural gas). There are other possible fuel sources for utilities in the future, including nuclear, wind, water, solar, and geothermal. However, these are not yet perfected so that utilities can switch over to these sources in order to preserve our dwindling fossil fuels.

Distribute the activity sheet, "Present Energy Sources," showing two small maps of present energy sources.

Discuss what these maps show, generally, but do not go into specifics.

Distribute the "Fuels That Utilities Burn" activity sheet. (You might point out that Idaho shows no fuel being burned in that state--someone will be sure to notice it! Simply an omission.)

Have students complete the "Present Energy Sources" activity sheet without further discussion. They will be using the skill of gathering information from maps and using that information to make conclusions.

Evaluation: Using a transparency of "Oil and Gas Fields in the United States" (Appendix A-25) discuss:

How do utilities in states that do not have oil and gas fields get their fuels?

How does that affect the cost of the utility to the customer?

How do you suppose these fuels are transported?

Using a transparency of "Coal Fields in the United States" (Appendix A-24) discuss the same questions.

PRESENT ENERGY SOURCES

Oil and natural gas account for 78% of the energy used in the United States. We are using up this limited natural resource fast. The United States uses more energy than any country in the world.

Use the two maps showing energy resources and the map, "Fuels That Utilities Burn," to help you answer some of these questions.

1. In the year 2000 it is possible that our supply of oil and natural gas will be used up. How many years away is the year 2000?

   ________ How old will you be? ________

2. What are some things that would have to change if we had no more oil or natural gas?

   ____

   ____

   ____

3. On the map, "Fuels That Utilities Burn," label the directions NORTH, SOUTH, EAST and WEST. (Use a wall map or an atlas if you need help.) When you are sure you have the directions labeled correctly, put a check (✓) in this space: ____

4. Utility companies burn fuel to make electricity. This map shows the fossil fuel use of the utility companies in each state. Which states burn only gas?

   Texas, Oklahoma, Louisiana

5. Which state uses only oil? *Washington*

6. Name three states that use only coal. *Wyoming, North Dakota, Michigan, Ohio, West Virginia, Vermont* (any three)

7. Which states use only gas and oil?

   California, Oregon

8. Which states use only coal and oil?

   Maine, New Hampshire

9. Which fossil fuel is used most? *coal*

10. Which fossil fuel does California use most? *gas*

11. What part of the country uses mostly coal? *eastern*

12. What part of the country uses no coal? *west coast*

13. Now look at the sheet that has two small maps on it. Using the "Utilities" map and the small "Coal Fields" map, what can you say about why coal probably is not used on the west coast?

no coal deposits

14. Use the maps to explain why Texas, Oklahoma, and Louisiana utilities burn the fuel they do.

large deposits of oil and natural gas

15. Why do you think North Dakota uses coal instead of oil or natural gas?

large coal deposits

16. Locate Minnesota on the "Utilities" map. What fuels are used there?

coal, gas

How much oil and natural gas does Minnesota have as a natural resource?

none

How do you think Minnesota utilities get the fuel they burn?

buy it from other states

How would this affect the cost of electricity in Minnesota?

would cost more, be more expensive

17. What do you think would happen to a state like Nevada that has no coal and very little oil and gas if other states would not sell them these energy sources?

____

____

18. If you were in control of all the oil and gas resources in California, would you sell these resources to Nevada? ________
Why? ________________________________

____

19. If all the oil and gas in California was used up, what would you do?

____

____

20. Write a letter to the governor of California suggesting what you think should be done. (Think of the proper form for writing a letter to the governor. Be sure to state reasons for your suggestions.)

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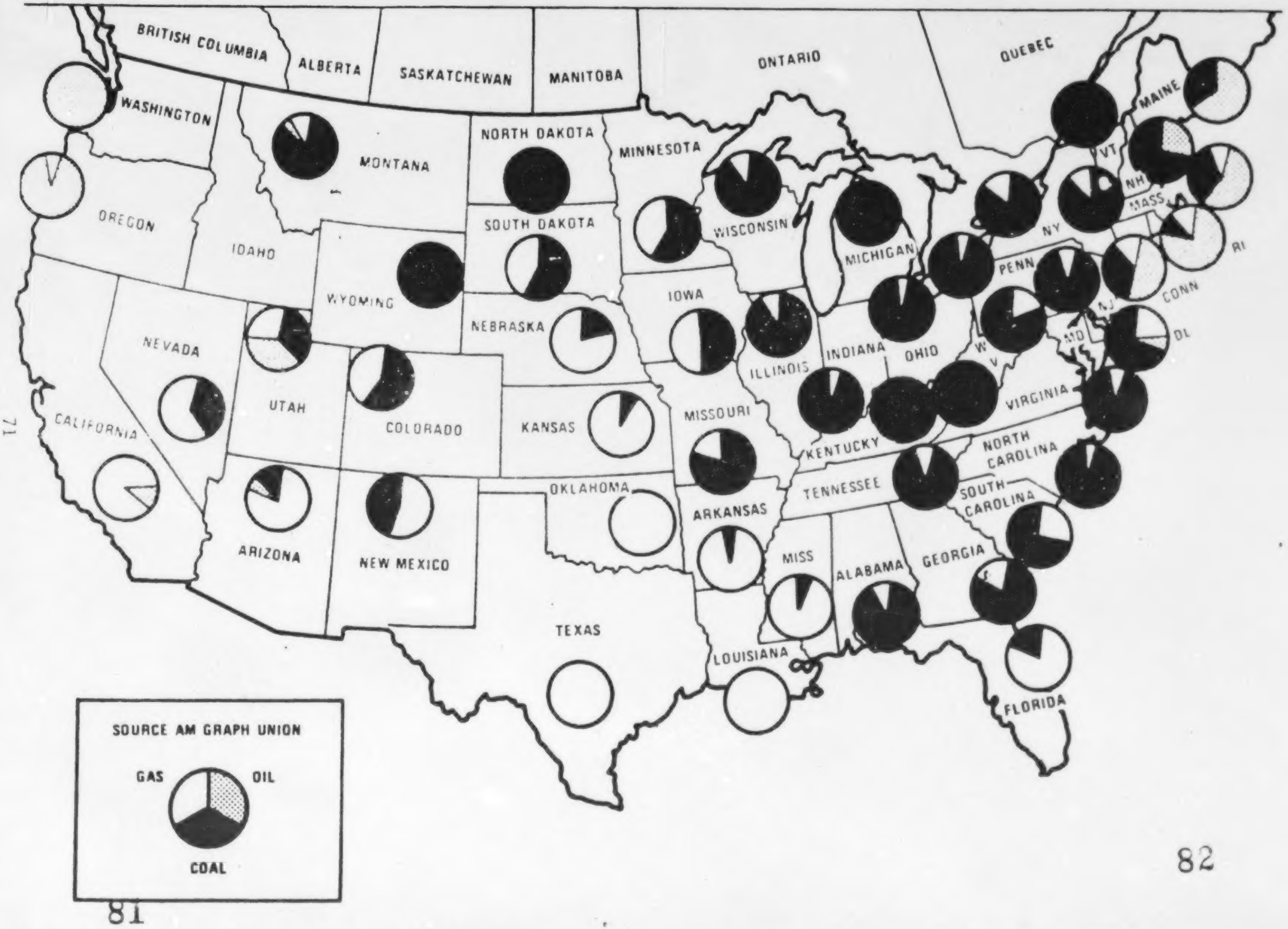
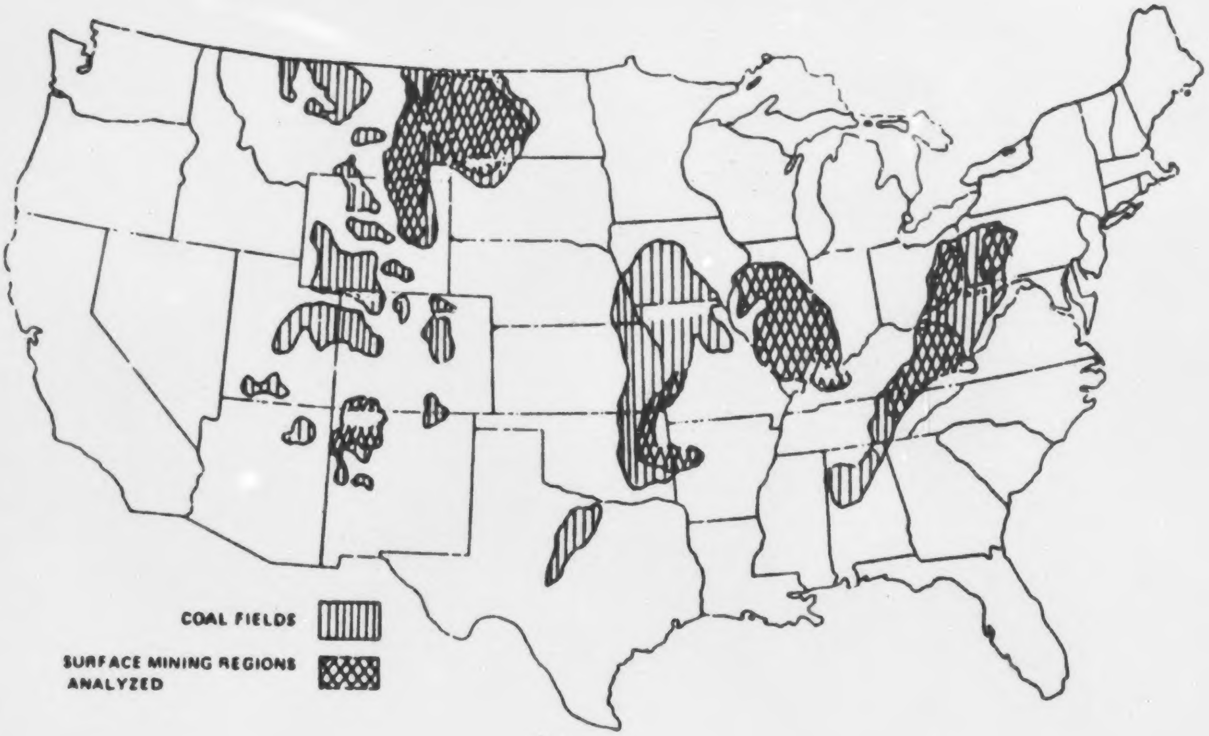
FUELS THAT UTILITIES BURN

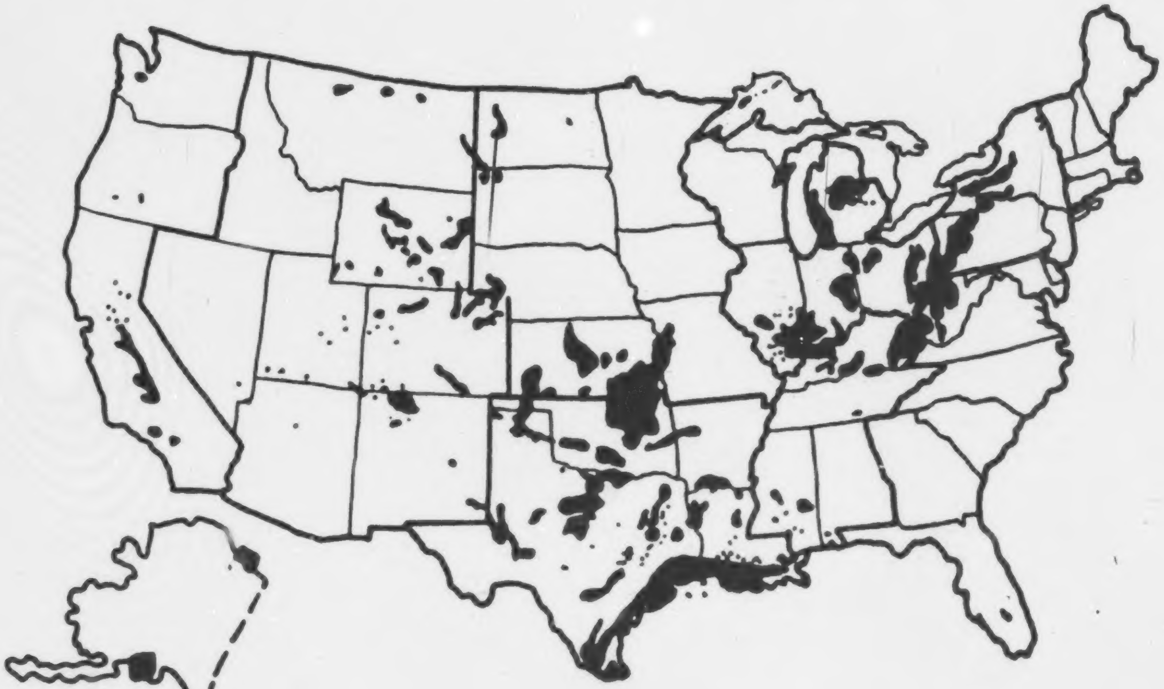

BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
MAINE
VT
NH
MASS
RI
OREGON
IDAHO
SOUTH DAKOTA
WISCONSIN
MICHIGAN
NY
CONN
WYOMING
NEBRASKA
IOWA
PENN
NJ
MD
DL
NEVADA
UTAH
COLORADO
KANSAS
ILLINOIS
INDIANA
OHIO
W
V
CALIFORNIA
MISSOURI
KENTUCKY
VIRGINIA
NORTH CAROLINA
OKLAHOMA
ARKANSAS
TENNESSEE
SOUTH CAROLINA
ARIZONA
NEW MEXICO
MISS
ALABAMA
GEORGIA
TEXAS
LOUISIANA
FLORIDA
GAS
OIL
COAL

SOURCE AM GRAPH UNION

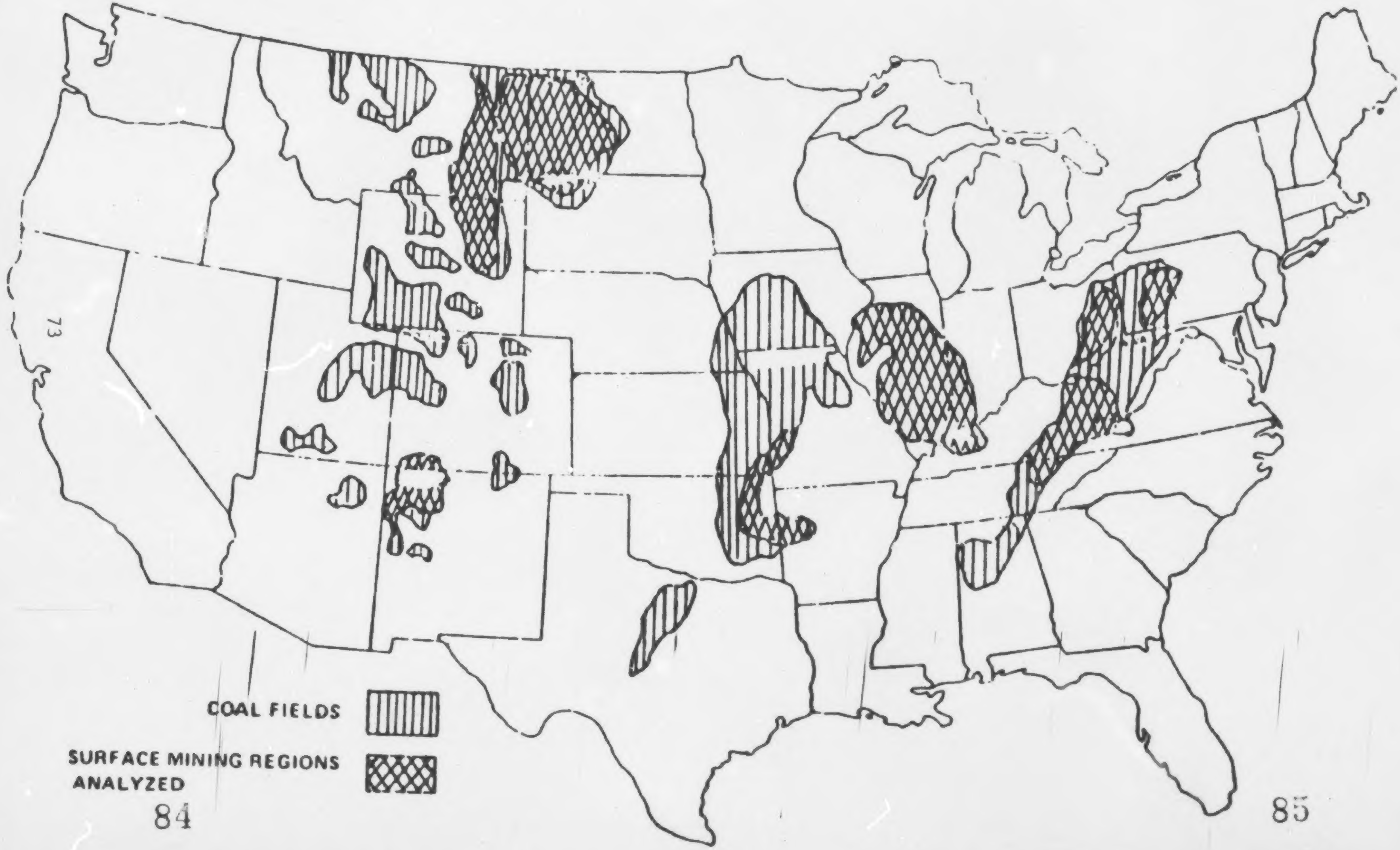
COAL FIELDS IN THE UNITED STATES


COAL FIELDS
SURFACE MINING REGIONS ANALYZED

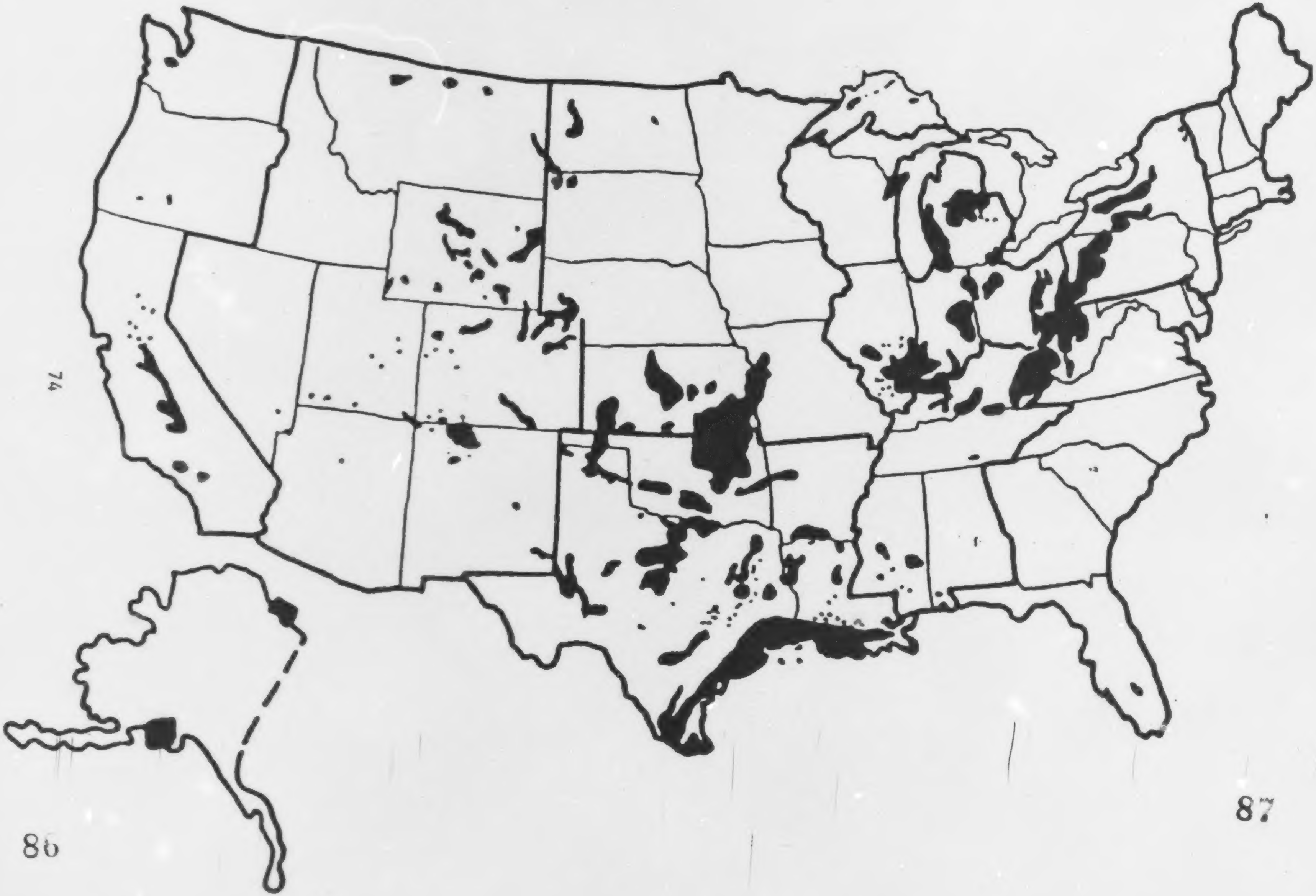
OIL AND GAS FIELDS IN THE UNITED STATES



COAL FIELDS IN THE UNITED STATES


COAL FIELDS ▥
SURFACE MINING REGIONS ANALYZED ▩

OIL AND GAS FIELDS IN THE UNITED STATES

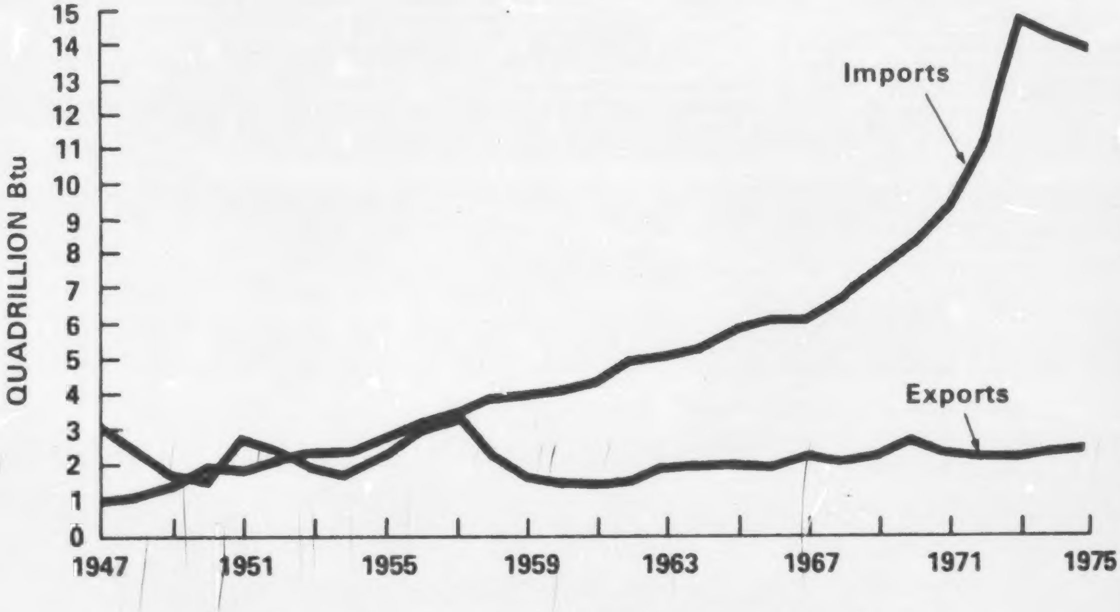


ACTIVITY 19

Learning: Resources from the land are not distributed evenly throughout the world.

Materials: World map (individual student map), "World Estimated Crude Oil Reserves" graph (Appendix A-26), "World Recoverable Coal Reserves" graph (Appendix A-27), "World Estimated Natural Gas Reserves" graph (Appendix A-28), "World Map" transparency master (Appendix A-29), "World Sources of Energy" activity sheet (Appendix A-30)

Teacher Information:


U.S. Trade in Fossil Fuels

U.S. petroleum imports have exceeded petroleum exports since 1947. Petroleum imports, measured in trillion Btu, have increased at 9.7% growth rate since 1947. In 1974, U.S. petroleum imports constituted 92% of total U.S. energy imports measured in trillion Btu.

Natural gas imports have increased at an annual rate of 12% since 1958.

U.S. coal exports constituted 78% of U.S. energy exports in 1975.

Except for 1950, during the 1947-52 period, the United States exported more energy than it imported. However, since 1953, U.S. fuel imports have exceeded fuel exports.

This activity will involve students in gathering data from graphs and using that data to make comparisons of the three major energy sources which presently account for most of the energy in the world. The graphs will indicate the world distribution of these energy sources.

Since the activity is quite lengthy, you may need to space it out over several days.

Procedure: Explain to students that, although people of the different regions of the world differ in looks, customs, and the way they do things (their life-style), they all have basic needs that require some use of energy. Energy resources, like the people, differ over each region of the world. Some regions have little or no energy resources, while others have an abundant supply.

Show the transparency, "World Map" (Appendix A-29). Explain that this map has the world divided into seven regions, and that we are going to be looking at three energy resources of each of these regions. Identify each region and name some of the countries in each region.

Distribute the "World Sources of Energy" activity sheet (Appendix A-30).

Make sure students are able to read the map and the graphs. Have them complete the activity sheet.

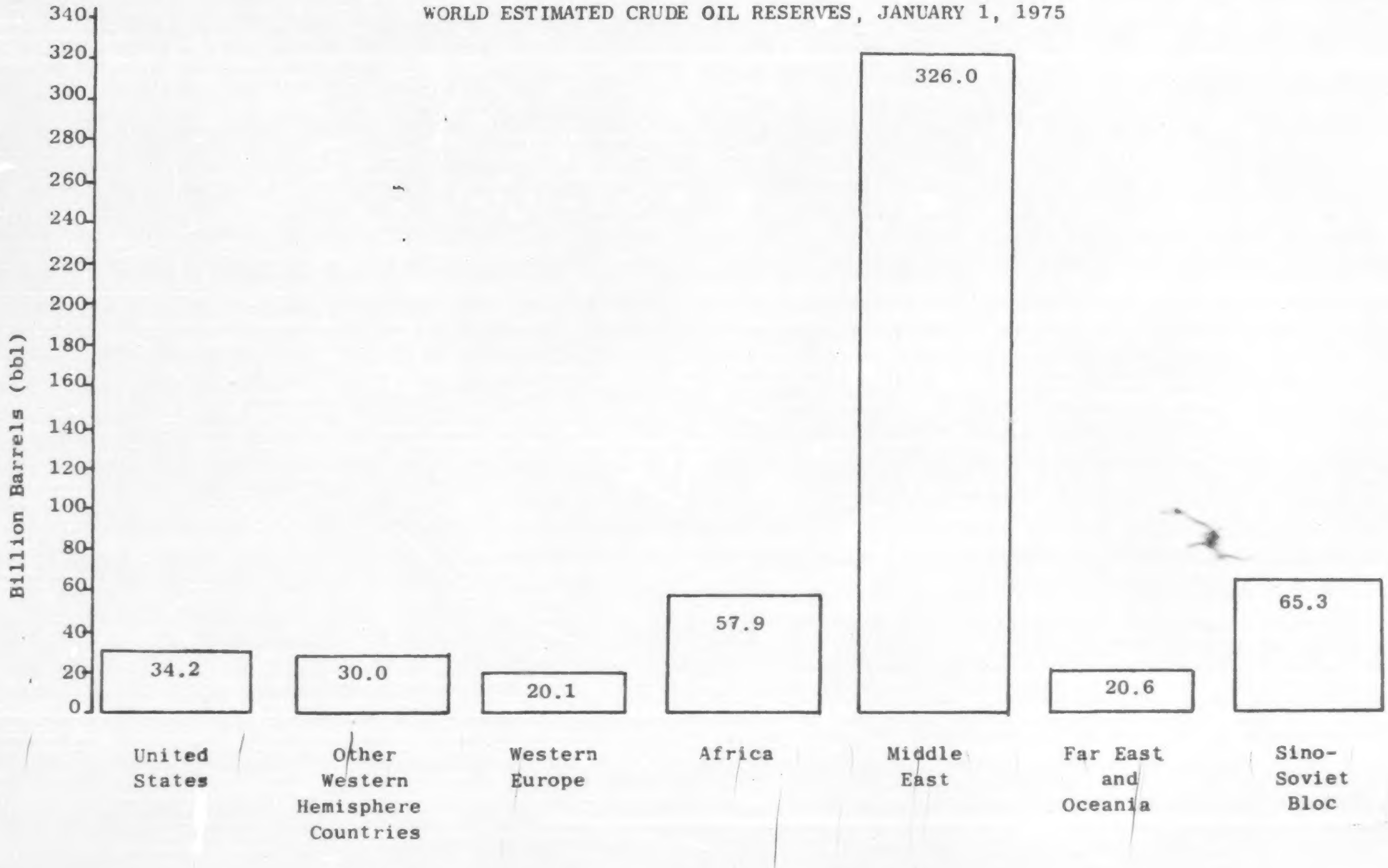
Evaluation: After the activity sheets have been completed, discuss the worldwide distribution of each of the three energy resources. Discuss the implications of the interdependent nature of world trade for these resources.

Say: "It is clear that, while all countries in the world need these resources, not all countries have deposits within their national boundaries. What do you think should happen? Should each country take care of its own needs? Should each country by energy-independent? That is, if a particular country has very limited resources for energy, should they simply adjust their way of living (life-style) to that supply? Or should these resources be considered the property of 'the world'? Should each country have an equal portion of the world's resources?"

Allow students to express their views, always giving *reasons* for these views. With the data they gathered from the activity sheet, students should have some basis for their positions rather than just opinions.

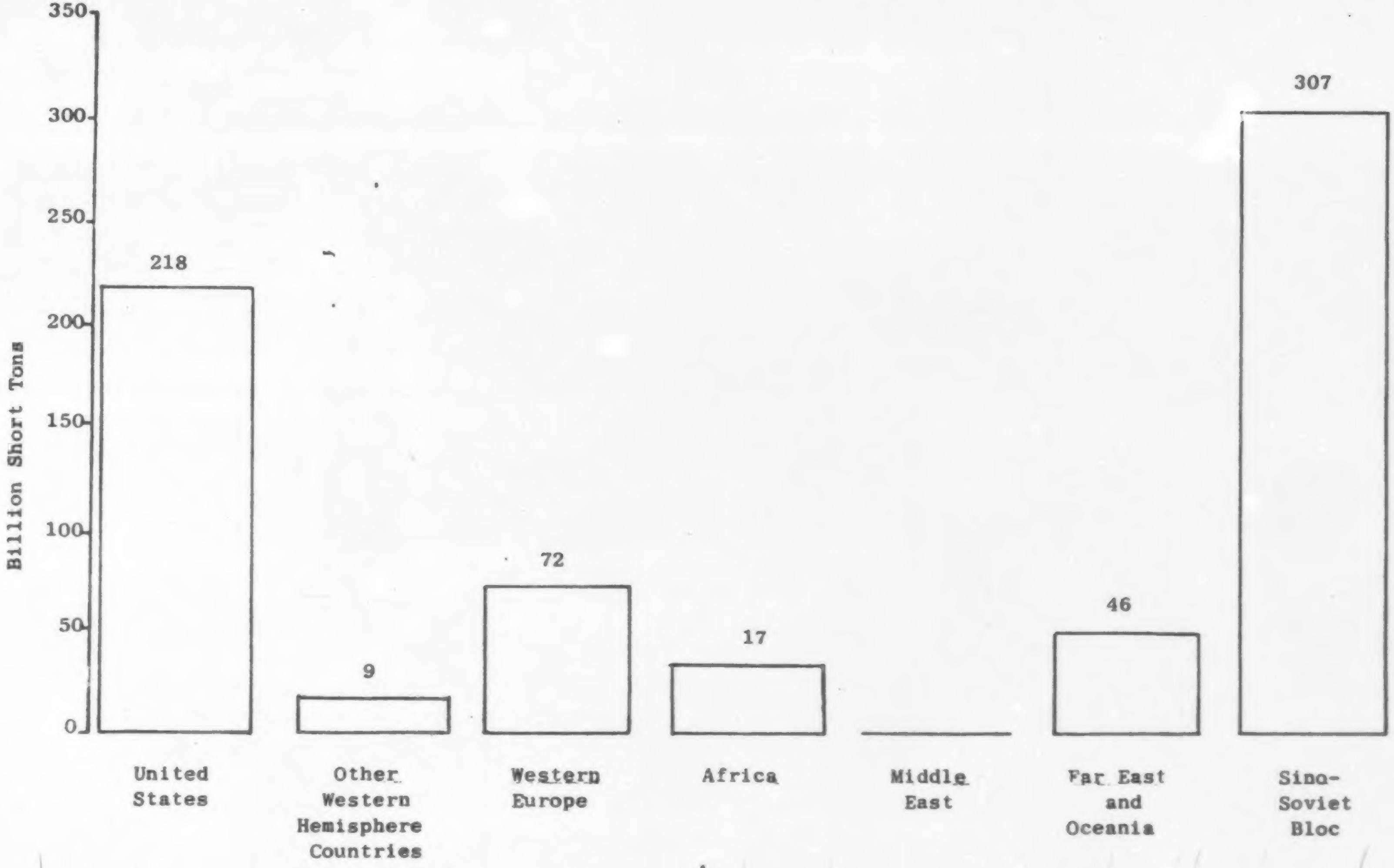
Finally, discuss the implications for the United States. Ask: "How should the leaders of this country procede with energy policies?"

WORLD ESTIMATED CRUDE OIL RESERVES, JANUARY 1, 1975



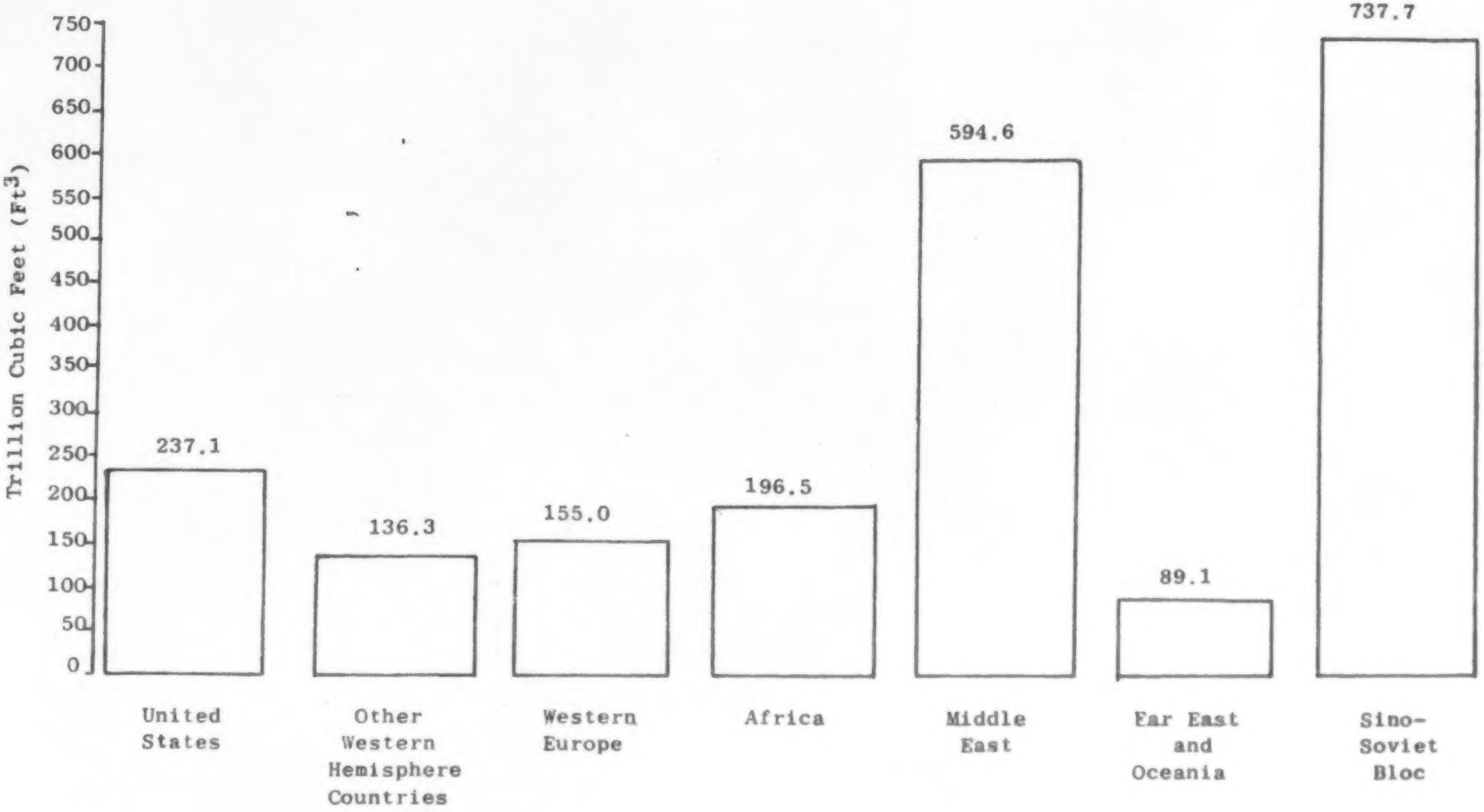
Source: Energy Perspectives 2, U.S. Department of Interior, June, 1976

WORLD RECOVERABLE COAL RESERVES, 1974



Source: Energy Perspectives 2, U.S. Department of Interior, June, 1976

WORLD ESTIMATED NATURAL GAS RESERVES, JANUARY 1, 1975



Source: Energy Perspective 2, U.S. Department of Interior, June, 1976

WORLD SOURCES OF ENERGY

Look at the three graphs:

1. Estimated Crude Oil Reserves
2. Estimated Natural Gas Reserves
3. Recoverable Coal Reserves

After looking at the three graphs, answer the following questions. (You will also need your copy of a world map to help you with this activity sheet.)

1. How many different countries, continents, or areas of the world are listed on each of the three graphs?

   Answer: 7

2. Are the names of the countries or areas the same on each graph?

   Answer: Yes

3. List the names of the countries or areas found on the graphs.

   Answer: United States

   Other Western Hemisphere Countries

   Western Europe

   Sino-Soviet Bloc

   Africa

   Middle East

   Far East and Oceania

4. Use the Crude Oil Reserves graph to answer the following questions:

   a. Which country or area has the greatest amount of crude oil in reserve?

      Name: Middle East

      What is the number amount in billions of barrels of oil listed for this country or area?

      Amount: 326 or 326,000,000,000

   b. Which country or area has the least amount of crude oil in reserve?

      Name: Western Europe

What is the number amount in billions of barrels of oil listed for this country or area?

Amount: 20.1 or 20,100,000,000

c. What is the number amount in billions of barrels of oil listed for the United States?

Amount: 34.2 or 34,200,000,000

d. Compare the United States with the other six areas of the world by listing those areas with more and those areas with less crude oil in reserve than the U.S.

AREAS WITH MORE CRUDE OIL	AREAS WITH LESS CRUDE OIL
Africa	Other Western Hemisphere Countries
Middle East	Western Europe
Sino-Soviet Bloc	Far East and Oceania

e. What is the total amount of crude oil in reserve for the whole world? (Hint: If you know what the total is for each of the seven areas, what must you do to get the entire sum for the world?)

Amount: 556.1 or 556,100,000,000

f. Add up the total oil reserves for all areas of the world except the Middle East. Total for the six areas:

230.1 or 230,100,000,000

g. Do the six areas of the world (which include the United States) have more or less total crude oil in reserve than the Middle East?

Answer: Less

h. State any ideas or conclusions that you now have on crude oil reserves in the world. Use any data given on the chart to support your conclusions.

Answers will vary. They should be able to see that the Middle East has more than half of the world oil reserves and that the United States is relatively poor in world comparison.

4. If you were in the business of selling oil well drilling equipment, what area or areas of the world would you go to first?

Answer: Middle East, Sino-Soviet Bloc,

Africa, United States

5. Look now at the graph entitled "World Recoverable Coal Reserves, 1974."

a. List in order, from the largest number to the smallest number, the names of the countries or areas, and record the number amount next to the name.

COUNTRY OR AREA NAME	NUMBER AMOUNT LISTED FOR EACH COUNTRY
Sino-Soviet Bloc	307
United States	218
Western Europe	72
Far East and Oceania	46
Africa	17
Other Western Hemisphere Countries	9
Middle East	-- (nothing or zero)

b. Oil is recorded in billion barrels (bbl). Find and write down the way coal is weighed and recorded on your coal reserves map.

Answer: billion short tons

c. Look in a dictionary under "Weights and Measures" (usually listed in the back of the dictionary), and find out what a short ton is and write the weight down.

Answer: 2,000 pounds

d. The United States has 218 billion short tons (218,000,000,000) of coal in recoverable reserves. How many pounds are there in 218,000,000,000 short tons? (Hint: If you know what the weight of one short ton is, what would you do to find the product sum of 218,000,000,000 short tons?)

Answer: 436,000,000,000,000 pounds

e. Look back at your answer to 5a and add up the world's total recoverable coal reserves (in billion short tons) and record your answer.

Answer: 669 billion short tons

f. From the graph on world coal reserves we can see that the United States has a lot of coal--but, what is a lot? To find out specifically, we can compare the United States total to the world total in fraction form. The numerator of the fraction is the United States total and the denominator is the world total. Find these two numbers and record your answer in fraction form.

Answer: $\frac{218}{669}$

Now, drop off the last two numbers of the numerator and denominator and write down your new fraction.

Answer: $\frac{2}{6}$

Can you simplify (reduce) the fractional number that you just wrote? If you can, what is your answer?

Answer: $\frac{1}{3}$

You now know the approximate fraction of the total world coal that the United States has in reserve.

g. What information have you learned or what conclusions can you make from your learnings on world coal reserves? (Use any data on the chart to support your answers and conclusion.)

Answer: Answers will vary. Students should be able to see that the United States and the Sino-Soviet Bloc have about 5/6 of the world total of coal and the rest of the world is relatively coal-poor.

6. Look at your third map on natural gas resources in the world. Tell what unit of measure is used to record natural gas. (Remember that coal is recorded in short tons and oil is recorded in barrels.)

Answer: Trillion cubic feet (ft^3)

a. List the number amount (in TRILLION CUBIC FEET) for the United States, and tell how the United States ranks in relation to the other countries or areas of the world.

Answer: 237.1 trillion cubic feet; the United States has the third largest amount in the world.

b. Suppose the United States needed to buy natural gas. If the Sino-Soviet Bloc countries would not sell natural gas to the United States, where would be the next best location for purchasing natural gas? List the country or area and its number amount.

Name: Middle East

Amount: 594.6 trillion cubic feet

c. What means of transportation do you think would probably be used to get natural gas from the Middle East to the United States? Trace your route on a world map and write down the names of the land areas and bodies of water over which you would travel.

Answer: Probably ship (supertanker, etc.); route will vary--accept any reasonable answer.

d. If we have to pay $100 a mile for transporting natural gas from the Middle East to the United States, how much would transportation costs add to the cost of the natural gas that was purchased? (Hint: Trace your route on the map with yarn and find out in the legend the scale of inches to miles. When you find out how many miles your route covers, then multiply by $100 per mile.)

Answer: Answers will vary between $1,500,000 and $3,000,000 depending on route.

e. What have you learned about the cost of natural gas to our country when it has to be imported?

____

____

7. We have covered many ideas on the topics of oil, coal, and natural gas. From what you have learned, and by using the three graphs, summarize what you know (in your own words) about these three energy resources.

Answers will vary. Students should see that the United States does not have very much (approximately 1/7 total) of the vital energy resources of the world, and coal is our most abundant energy resource.

____

101

ACTIVITY 20

Learning: Because of our life-style, we use more oil than we can produce in this country; therefore we must import oil from other countries.

Materials: "The Oil We Import" activity sheet (Appendix 31)

Teacher Information: The purpose of this activity is twofold. It will involve the student in the *skill* of interpreting a graph and concluding about data gathered from that graph, and it will introduce a crucial *concept* in the understanding of this country's energy problem--that we use more oil than we produce, therefore we must rely on other countries to help satisfy our appetite for energy.

Procedure: Be sure students know what these words mean before distributing the activity sheet:

import regulate domestic alternative

Distribute "The Oil We Import" activity sheet and locate these countries on a world map:

Canada
Iran
Venezuela
Algeria
Indonesia
Ecuador
Saudi Arabia
Nigeria

As each country is located, define the "world region" in which it is located: North America, Latin America, Mideast, Africa, Southeast Asia.

Have students read the paragraph at the top of the activity sheet. Discuss the reasons for the increase in U.S. imports and the resulting rise in the cost of gasoline, for instance.

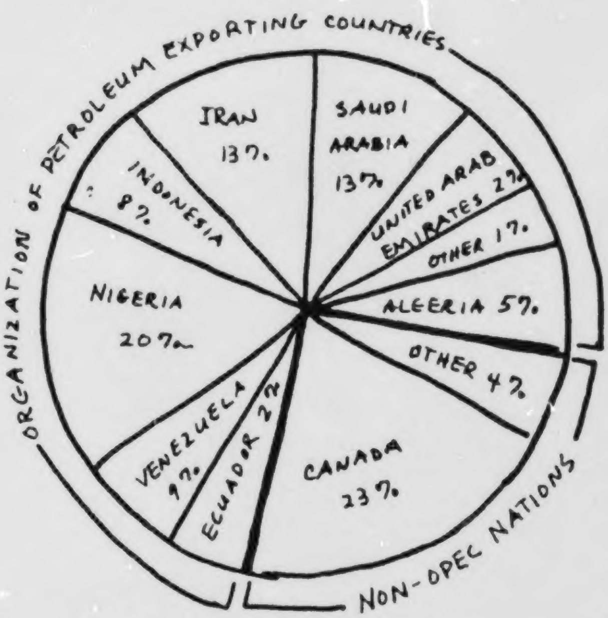
Using the graph as a source of data, have students complete the activity sheet.

Evaluation: Discuss, as a class, the answers to #7. Students will be concluding from the data on the graph. Ask for the data that verify their conclusions.

Discuss the answers to #8 (the reactions to "solutions to oil shortage"). Insist that students give *reasons* for their answers.

THE OIL WE IMPORT

Because America's demand for oil is greater than its supply, we must buy oil from other countries to help meet the demand. This is called *importing*. From 1969 to 1974 our imports of oil doubled, and the cost per barrel increased more than four times.



PERCENT OF TOTAL U.S.
CRUDE IMPORTS IN 1974

1. Find each country shown in the graph on a world map. Then, below, list each country in its proper region. Beside each country's name write the percentage of oil the U.S. imports from it.

North America

________________ ______

Latin America

________________ ______

________________ ______

The Mideast

________________ ______

________________ ______

________________ ______

Southeast Asia

________________ ______

________________ ______

Africa

________________ ______

________________ ______

2. The OPEC nations have formed an association to regulate the price they charge for their crude oil. What do the letters OPEC stand for?

____

3. What are the OPEC nations? ____

____

4. What percentage of imported U.S. oil comes from OPEC nations? ______

5. The country that sells the U.S. the most crude oil says it will need to end all shipments to the U.S. by 1982. Which country is this?

____

6. Why does the U.S. need to import oil? ________________________

____

7. From what you have just done, what would you say about the oil shortage in the United States?

____

____

8. React to these solutions to our oil shortage. State whether you agree or disagree and *give reasons* for your answers.

We should increase domestic production of fossil fuels.

____

____

We should decrease our demand for oil.

____

____

We should develop new energy alternatives.

____

____

We should increase oil imports to meet our growing demand for it.

____

____

We should stop importing. We should become energy-independent.

____

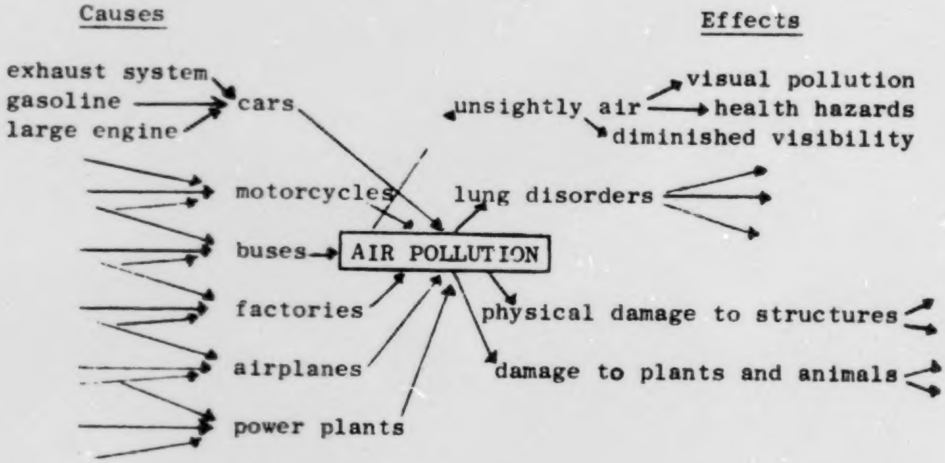
____

ACTIVITY 21

Learning: Environmental problems related to the use of energy have many causes and effects.

Teacher Information: The purpose of this lesson is twofold: Students will be learning (1) the *skill* of recognizing cause and effect relationships and (2) the relationship of energy use to various environmental problems. The lesson should be repeated several times simply changing the focus (e.g., water pollution, misuse of natural resources, etc.).

Example of diagram for cause-effects lesson:


Causes
Effects
exhaust system
gasoline
large engine
cars
motorcycles
buses
factories
airplanes
power plants
AIR POLLUTION
unsightly air
visual pollution
health hazards
diminished visibility
lung disorders
physical damage to structures
damage to plants and animals

Procedure: Identify a problem regarding an environmental concern generated by the use of energy. Place in the center of the chalkboard, and box it so that it becomes a focal point.

On the left side of box place the heading "Causes" and on the right "Effects." Under the heading "Causes" elicit several causes of the problem by asking, "What are some causes of the problem (e.g., air pollution)?" Be sure to get at least five or six on the chalkboard. After causes have been recorded, explore *prior causes* by asking, "What are some things that have caused ______________ (e.g., 'cars' to contribute to air pollution)?" Get several prior causes for each cause.

Under the heading "Effects" elicit several effects generated by the problem by asking, "What are some things that have happened because of the problem (e.g., air pollution)?" Be sure to list at least five or six effects. After effects have been listed, get *subsequent effects* by asking, "What has happened because of ______________ (e.g., 'unsightly air')?" Get several subsequent effects for each effect. See diagram for example.

Evaluation: Have students make a conclusion based on the discussion, verifying the conclusions with reasons. Do not let students simply summarize the exercise--have them make a conclusion. After the conclusion has been stated, ask, "What was said in the discussion that makes you say that?" (Be sure other data are not brought in.)

ACTIVITY 22

Learning: Life-styles have an impact on the environment.

Materials: "'Check Your Life-Style' Inventory" activity sheet (Appendix A-32)

Procedure: As a culminating activity for this objective, review the components of our natural system and their interrelated nature. Review the various ways people misuse and/or abuse our environment. Point out that the *way people live* (their life-style) has an impact on the environment. Further, point out that our use of energy (a part of our life-style) has a tremendous impact on our environment because we use so much energy.

To bring the discussion down to the personal level of the child, discuss examples that would explain why we are called a "throw-away society" (paper towels, aluminum cans, styrofoam cups, plates, etc.) Point out that these have become a part of our "life-style." On the other hand, recycling has become a part of some families' life-style(newspaper, aluminum, glass).

Have students take a few minutes to just think of some of the things their family does regularly (drive a car, watch TV, use a washing machine, cook meals on an electric or gas range, use a refrigerator, buy clothes, makes clothes, etc.)

Distribute the "'Check Your Life-Style' Inventory" and have students complete it individually.

Evaluation: After the inventories have been completed, discuss them. Have volunteers complete this sentence: "By doing this activity I learned ____________________________."

Extended Activity: Say to students, "You have been asked by a local radio station to prepare an announcement for their 'public interest' spot, urging the public to become more aware of how life-style affects the environment. It is an important message, so word it carefully."

After the announcements have been written, have volunteers give their "public interest message" to the class. Allow time between each one for students to react to the message. (How did it make them feel?)

"CHECK YOUR LIFE-STYLE" INVENTORY

1. What does life-style mean? ______________________________

____

2. List at least 10 things that make up your life-style:

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

3. Put a star (*) beside the ones that require energy from a non-renewable resource.

4. Put a circle (o) beside the ones that come from a natural resource.

5. Put a check (✓) beside the ones that would cause some kind of pollution.

6. What is one thing you could change that would save energy?

____

How would that affect your life-style? ______________________

____

7. What is one thing you could change that would conserve a natural resource?

____

How would that change your life-style? ______________________

____

8. Make a statement about how your life-style is affecting our environment.

____

____

OBJECTIVE 4: *Students will identify advantages and disadvantages of some possible future energy sources.*

ACTIVITY 23

Learning: There are several resources available for future energy use.

Materials: Available material on energy sources, Energy Source Fact Sheets (Appendix B), "Future Energy Resources" activity sheet (Appendix A-33)

Teacher Information: People in industrialized nations have reached a high standard of living because of cheap energy from fossil fuels. Many facets of our lives are affected by the supply and use of these fossil fuels. As world population continues to grow, there will be a further strain on our limited energy resources. There is little doubt that the energy crisis will be a problem that confronts students as they grow older. They need to become aware that they will have to make decisions about energy use.

Procedure: Ask students to imagine that a disease killed all the wheat on earth and that there is only enough flour left to make bread for another month or two. Ask: "What would you do? Would you buy all the bread you could from the store? Would you try to find something else to use in place of bread made from wheat flour?"

Explain that we are facing a similar situation with the fossil fuels we use. We can go on using them until they are gone (which means the students themselves will have enough to use but their children probably will not) or we could start looking for other sources from which we could get energy.

Discuss these two points:

> Why should we or should we not be concerned with future generations?
>
> Why should we or should we not look for alternative sources of energy?

Before students begin their reading and work on the activity sheet, "Future Energy Resources," discuss the criteria for evaluating a future energy resource. (List on chalkboard.)

1. Availability--to the entire world
2. Quantity--enough to meet all of our needs and to last for many generations' use
3. Inexpensive cost--so that no people are deprived of its use
4. Safe and non-polluting

However, keep in mind that there may be no one resource that meets all four requirements. Compromise may be necessary.

Have students complete the activity sheet.

Evaluation: Using the data that are now on their "Future Energy Resources" chart, evaluate each future resource by the criteria for future energy resources listed on chalkboard.

Have students decide which resource seems more feasible to them and *give reasons* for their decision.

Extended Activity: Have students choose one of the alternative energy resources and describe the possible jobs and training that will be needed to develop and use it.

FUTURE ENERGY RESOURCES

SOURCE	HOW IS IT PRODUCED?	IS IT		WHAT ARE ITS PROBLEMS?
		EXPENSIVE?	INEXPENSIVE?	
Nuclear				
Shale Oil				
Solar				
Geothermal				

SOURCE	HOW IS IT PRODUCED?	IS IT EXPENSIVE?	IS IT INEXPENSIVE?	WHAT ARE ITS PROBLEMS?
Wind and Water				

Give each resource a rank (from 1 to 5) in terms of the following questions?

A. Which energy source will last the longest?
B. Which will cost the least to develop?
C. Which will cost the least to use?
D. Which is found everywhere on earth?
E. Which will cause the least pollution?

ENERGY SOURCE	A	B	C	D	E	TOTAL
Nuclear energy						
Shale oil						
Solar energy						
Geothermal energy						
Wind and water power						

Which energy resource do you recommend we use for the future? ______________________

Why? ____

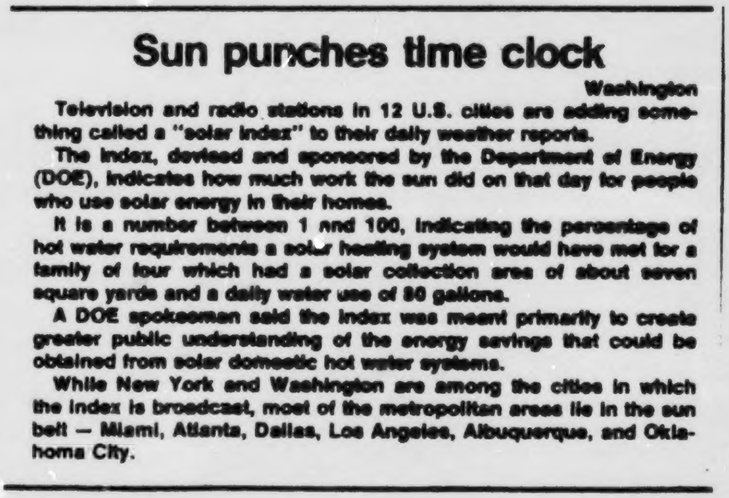
ACTIVITY 24

Learning: Solar and geothermal energy are being evaluated as possible sources for the future.

Materials: "Two Possible Future Sources of Energy" activity sheet (Appendix A-34), "Geothermal Resources in the United States" transparency master (Appendix A-35), "Potential Solar Energy by Region" transparency master (Appendix A-36), "Geothermal and Solar Maps" (Appendix A-37)

Teacher Information: For centuries people have been using geothermal energy. The ancient Romans turned places with hot springs into resort areas. There are some power plants in the world today converting geothermal steam into electricity. These geothermal resources were discovered because the hot water they form appeared at the surface of the earth, but not all the earth's hot spots produce hot water at the surface. Therefore, finding these hidden resources requires sensitive instruments that have only recently become available. If new resources can be located and developed into sources of usable energy, they will perhaps help fill the world's growing energy needs.

Energy from the sun helps to grow our food and give us light. Now, more and more people are using the sun's energy to heat their homes and their water. Solar energy is essentially an inexhaustible source. It is capable of meeting a significant portion of the nation's future energy needs with a minimum of known adverse environmental consequences.



Sun punches time clock

Washington

Television and radio stations in 12 U.S. cities are adding something called a "solar index" to their daily weather reports.

The index, devised and sponsored by the Department of Energy (DOE), indicates how much work the sun did on that day for people who use solar energy in their homes.

It is a number between 1 and 100, indicating the percentage of hot water requirements a solar heating system would have met for a family of four which had a solar collection area of about seven square yards and a daily water use of 80 gallons.

A DOE spokesman said the index was meant primarily to create greater public understanding of the energy savings that could be obtained from solar domestic hot water systems.

While New York and Washington are among the cities in which the index is broadcast, most of the metropolitan areas lie in the sun belt — Miami, Atlanta, Dallas, Los Angeles, Albuquerque, and Oklahoma City.

If solar energy provided 1% of the nation's energy needs by 1983, this would conserve approximately 100 million barrels of oil per year.

Procedure: Give students some background on these two potential energy sources for the future.

Distribute the "Two Possible Future Sources of Energy" activity sheet (Appendix A-34) and the "Geothermal and Solar Maps" sheet (Appendix A-37). Using the data from the maps, have students complete the activity sheet. They will be summarizing the data to form conclusions and evaluations of these two sources of energy as possibilities for the future.

Evaluation: Using transparencies of the two possible future energy sources of geothermal and solar ("Geothermal Resources in the United States," Appendix A-35, and "Potential Solar Energy by Region," Appendix A-36), discuss the following questions:

Which of these do you think would be more practical for a utility to use? Why?

Which do you think could be used more readily by individual homeowners? Why?

Which do you think could best serve as an alternative to fossil fuels while other sources are being developed? Why?

TWO POSSIBLE FUTURE SOURCES OF ENERGY

Two future energy sources may be geothermal energy (energy from deep inside the earth) and solar energy (energy coming directly from the sun). Scientists and engineers are working on how to use these two sources. There are other possible sources for future use, but this activity will look at only geothermal and solar.

1. Look at the map, "Geothermal Resources in the United States." In what part of the country are most geothermal resources found?

   western

2. In what part of the country are there very few geothermal resources?

   western and middle states

   How do you think this would affect Texas using geothermal as an energy source?

   probably would not use it right away

3. List four states that have no geothermal resources.

4. List four states that have a large amount of geothermal resources.

   How do you think this would affect California using geothermal as an energy source?

   probably could use it for a considerable amount of energy

5. Write a summary of what the map on geothermal resources shows.

6. In your opinion, what is the possibility of using geothermal energy as a source for the future?

Give reasons for your answer.

7. Now look at the "Potential Solar Energy by Region." What is the highest amount of potential solar energy?

569 In what state is it? *California*

8. What is the smallest amount of potential solar energy?

269 In what state is it? *Washington*

How would you explain these two facts?

9. List the four highest amounts of potential solar energy and give the state.

AMOUNT	STATE
569	*California*
549	*New Mexico*
540	*Arizona*
530	*New Mexico*

How do you think this would affect these states using solar energy?

10. Write a summary of what the map on potential solar energy shows.

____

____

____

11. In your opinion, what is the possibility of using solar energy as a source for the future?

____

____

____

Give reasons for your answer.

____

____

____

12. What recommendations would you make for the future use of these two sources (solar and geothermal) in the United States?

____

____

____

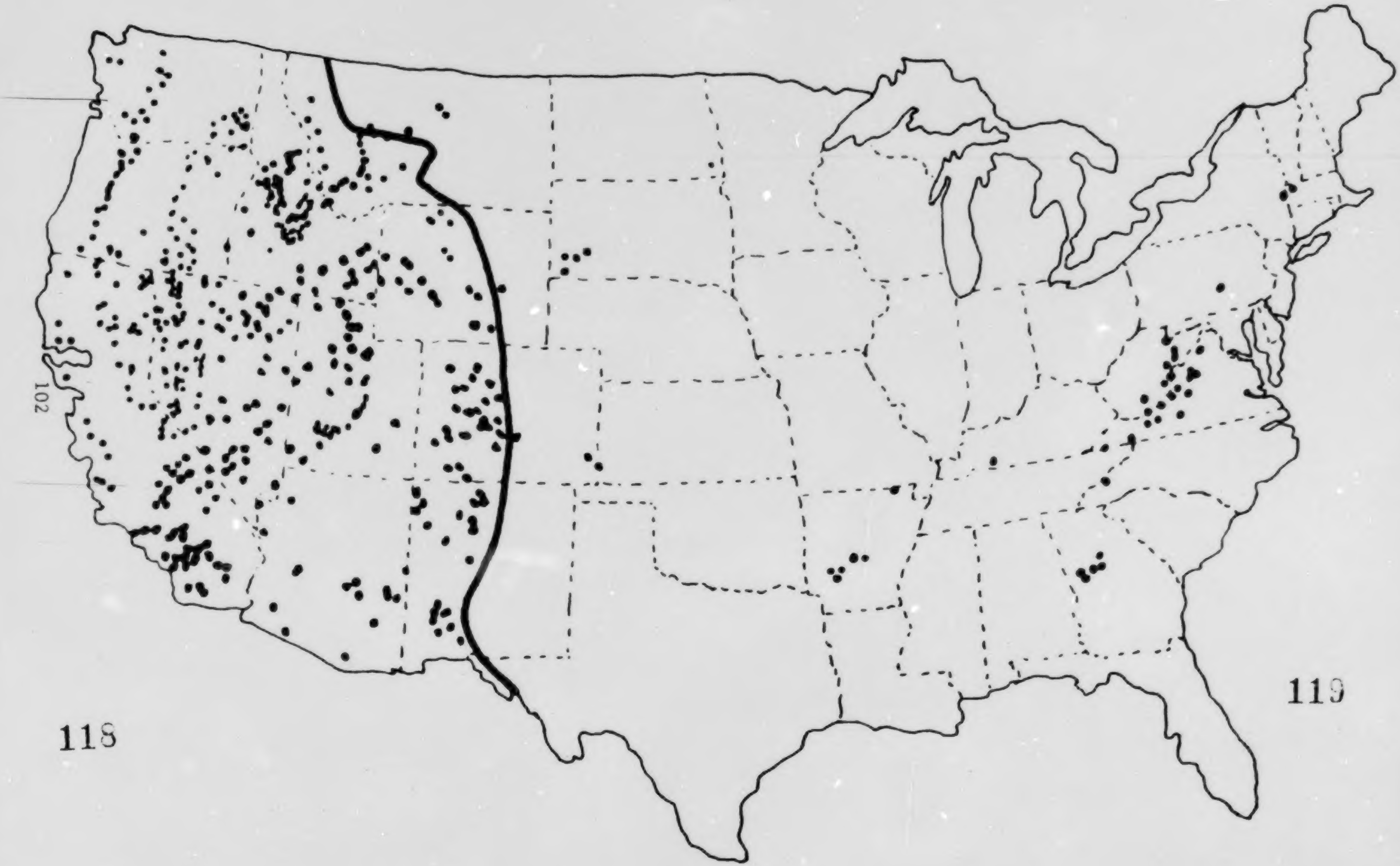
13. What recommendations would you make for the future use of these two sources in California?

____

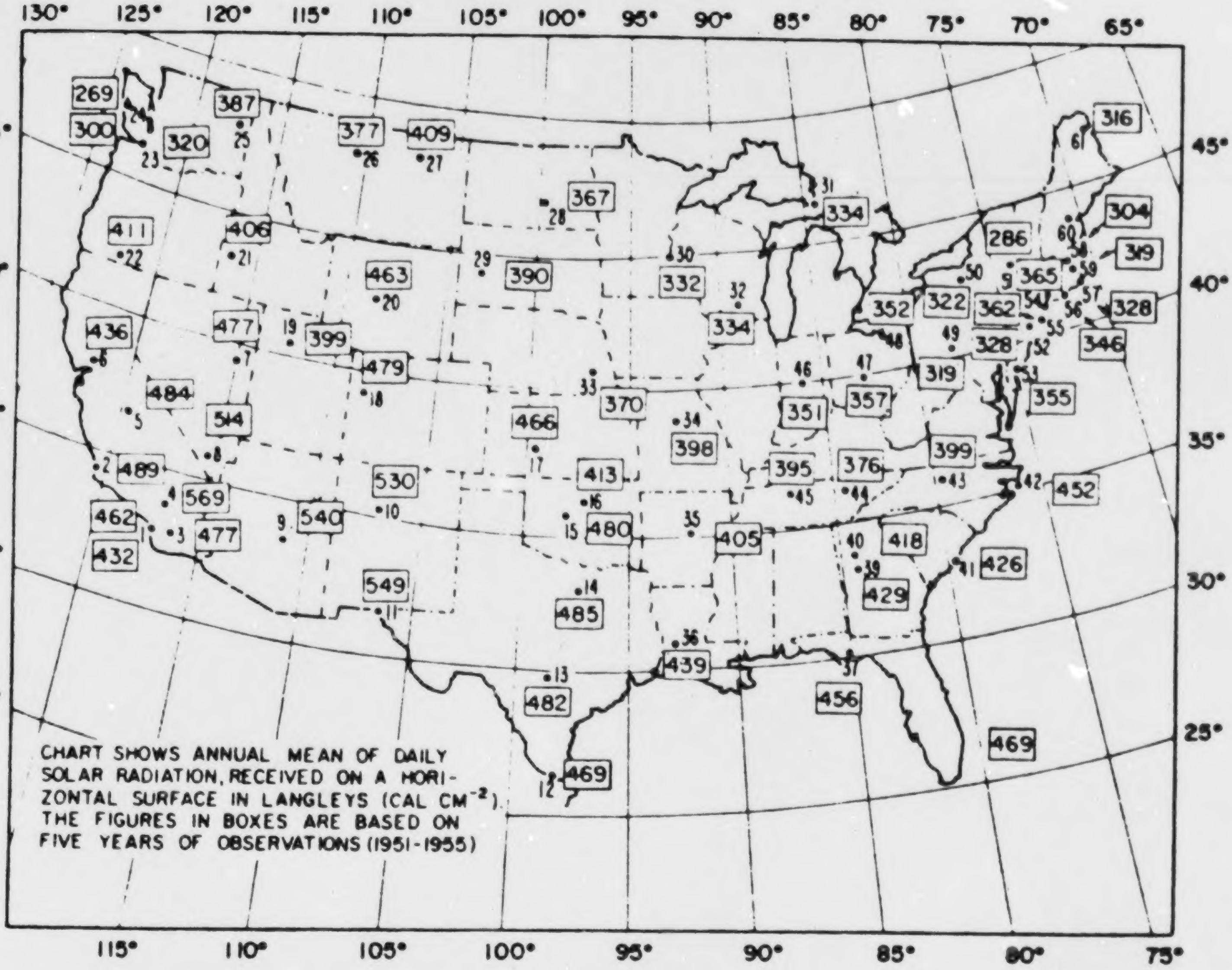
____

____

GEOTHERMAL RESOURCES IN THE UNITED STATES



POTENTIAL SOLAR ENERGY BY REGION


130° 125° 120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65°
45° 40° 35° 30° 25°
115° 110° 105° 100° 95° 90° 85° 80° 75°
269
300
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413
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426
432
429
549
485
439
482
456
469
469

CHART SHOWS ANNUAL MEAN OF DAILY SOLAR RADIATION, RECEIVED ON A HORIZONTAL SURFACE IN LANGLEYS (CAL CM^{-2}). THE FIGURES IN BOXES ARE BASED ON FIVE YEARS OF OBSERVATIONS (1951-1955)

FIG. 2 ANNUAL MEAN OF DAILY INSOLATION RECEIVED ON A HORIZONTAL SURFACE AT 61 LOCATIONS IN CONTINENTAL UNITED STATES

POTENTIAL SOLAR ENERGY BY REGION

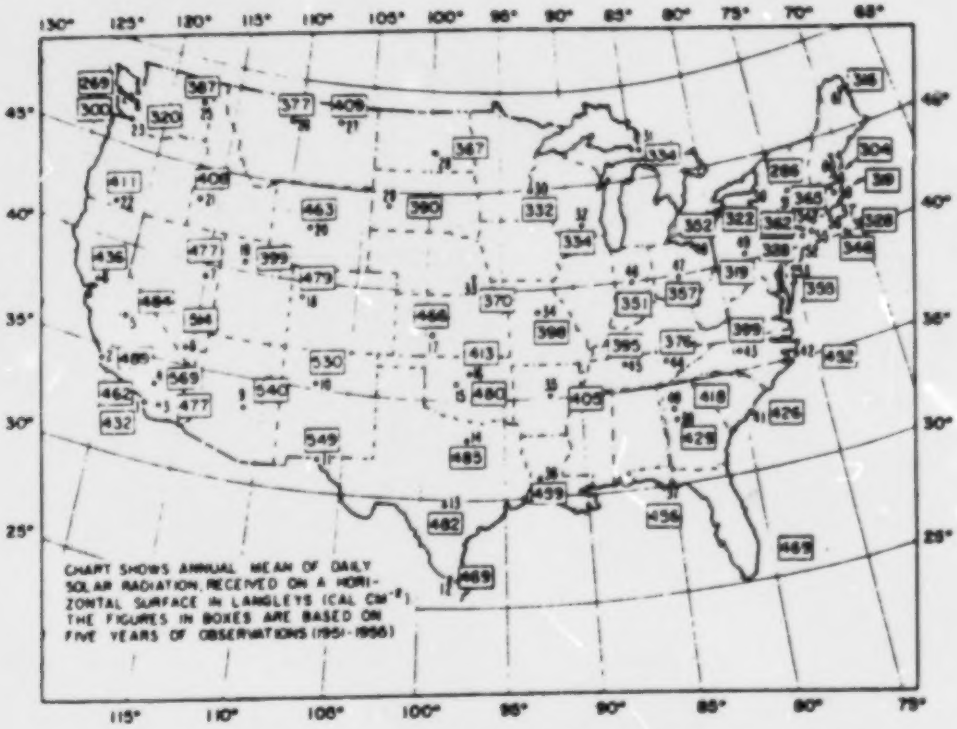
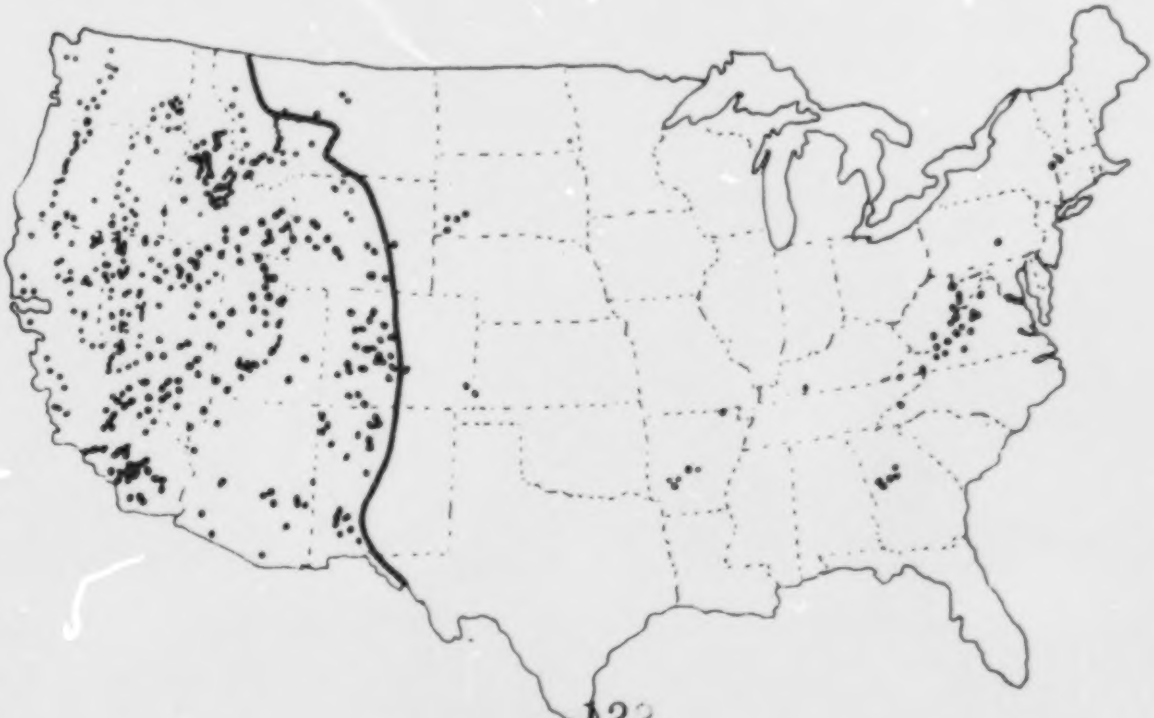

130° 125° 120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65°
45° 40° 35° 30° 25°
115° 110° 105° 100° 95° 90° 85° 80° 75°
CHART SHOWS ANNUAL MEAN OF DAILY SOLAR RADIATION, RECEIVED ON A HORIZONTAL SURFACE IN LANGLEYS (CAL CM⁻²) THE FIGURES IN BOXES ARE BASED ON FIVE YEARS OF OBSERVATIONS (1951-1956)

FIG. 2 ANNUAL MEAN OF DAILY INSOLATION RECEIVED ON A HORIZONTAL SURFACE AT 61 LOCATIONS IN CONTINENTAL UNITED STATES

GEOTHERMAL RESOURCES IN THE UNITED STATES



ACTIVITY 25

Learning: Coal is our most abundant fossil fuel. It provides us with opportunities and problems for the future.

Materials: "From Mine to Electric Light" activity sheet (Appendix A-38)

Teacher Information: Almost two-thirds of the coal mined in the central states is sent to electric utility plants. There it is crushed into a powder, mixed with air and blown into a boiler, where it catches fire. The fire then heats up large tanks of water. The steam from the heated water turns giant turbines. These turbines produce the power we know as electricity.

For many years scientists have been experimenting with coal in laboratories. In years to come, coal will be used in new ways. (Historically, it has always been burned in solid form.) While it is still quite expensive at this time to change coal into gas and oil, engineers are exploring ways to cut the cost down. Much research is being conducted to find new ways to process coal right next to coal mines to cut down the expense involved in transportation, new ways to process coke so that it will cause less pollution when it is burned, and many more.

Procedure: Distribute the "From Mine to Electric Light" activity sheet. Use it as data. Discuss each stage in the processing of coal in Part I of the activity sheet. (Elicit further information from students who have perhaps researched coal.)

Allow students some time to write several ways they use electricity and then discuss the items that have been starred in Part II.

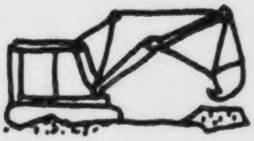
Part III of the activity sheet should be used in class discussion. Each fact should be clarified so that students understand it, and the group should decide whether it is a problem or an opportunity. Be sure to discuss precisely *what* causes the problem or creates the opportunity.

Answers to Part III:

1. O
2. P
3. O/P
4. O
5. P
6. O

Evaluation: Have students write a concluding statement about the use of coal as a future source of energy. Make sure they give facts that support their conclusions.

FROM MINE TO ELECTRIC LIGHT



I. Coal is mined either by surface or underground mining. Before it leaves the mine, it is cleaned, crushed, and sorted.

About two-thirds of our coal is transported by rail, much of it in special cars. One coal train can carry as much as 15,000 tons per trip.

Forty-six percent of U.S. generators are powered by coal. Power plants burn coal to turn water into steam. The steam turns a turbine (a series of wheels with vanes like a windmill). The turbine rotates coils of wire in a generator through a magnetic field to produce electricity.

Electricity is transported on wires at very high voltages. Electricity is usually not shipped more than 600 miles by wire because of expense and loss of energy. Only 26 percent of the original energy remains when the electricity is used.

Electricity lights the lamps in your home. How many other uses of electricity can you name?

II. ____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

Put a star beside the ones you think you could do without.

III. Decide whether the following fact is a problem (P) or an opportunity (O). Put a P or an O or both in the blanks.

_____ 1. 90 percent of the U.S. fossil fuel reserves (coal, oil, natural gas) is coal.

_____ 2. Some deep mines are dangerous.

_____ 3. 50 percent of our mineable coal is in the western states.

_____ 4. We have enough coal to last for 350 years at current level of use.

_____ 5. Mining coal can cause damage to the environment.

_____ 6. In the future, we will rely more on coal as a source of synthetic oil and gas.

ACTIVITY 26

Learning: Coal is an energy source that has served us in the past and may serve us in the future.

Materials: "Coal Reserves" activity sheet (Appendix A-39), "Coal Reserves Map" (Appendix A-40), United States map (wall map will do) showing states.

Teacher Information: This activity is twofold: Students will be (1) learning the skill of gathering information from a diagram and (2) using that information to reach conclusions about an energy source.

The figures on the diagram indicate percent of original deposit remaining. It shows us that, for future use, western states have a wealth of coal and eastern coal is depleting. You may use the diagram as a transparency or duplicate one for each student along with the activity sheet.

Procedure: Point out that nuclear, solar and geothermal sources are being developed slowly. While they may be widely used in the future, they are not ready for immediate use. Coal is an energy source that we are using now and have adequate reserves to view it as an energy source for the future.

Explain to students that coal has been used as an energy source for a long time. About 3,000 years ago, the Chinese began to burn coal. Marco Polo wrote about the "black stones" that people dug out of the mountains and burned. There is evidence that, as long as 700 years ago, Indians had used coal to fire their pottery.

However, in the early days of colonization in this country, wood was so plentiful on the East Coast (where most of the people were located), that it was not until the mid-1800's that coal was used in large amounts.

With this background, have students look at the U.S. coal reserves chart. Be sure they understand that the figures indicate the percent of the *original* deposit remaining.

Distribute activity sheet, "Coal Reserves." Have students complete it.

Evaluation: Discuss California's place in the nation's coal reserves.

Discuss Numbers 15-18 as a class.

COAL RESERVES

Using the coal reserves map and a map of the United States, answer the following questions. (You will need to know that the larger the number, the greater the amount of coal in the state.)

1. How many numbered states are listed on the coal reserves map?

   24

2. Which state has the largest amount of the original deposit remaining?

   State name: Montana

   Number amount of deposit: 99

3. What numbered state is east of the state with the largest amount?

   State name: North Dakota

   Number amount of deposit: 93

4. What is the name of the state furthest west on the map that has a large amount of its original deposit?

   State name: Oregon

   What is the number amount listed for this state?

   Number amount: 78

5. What two states have the same number amount of coal reserves?

   State names: Wyoming and Texas

   What is the number amount listed for those two states?

   Number amount: 98

6. What is the name of the state with the smallest (least) amount of its coal that is not yet used? (It must be a numbered state.)

   State name: Tennessee

   What is the number amount listed for this state?

   Number amount: 35

7. What numbered state is south of the state with the smallest (least) amount?

   State name: Alabama

Number amount: 36

8. Find New Mexico on the map and list the number amount for this state.

Number amount: 94

9. What is the name of the border state (touching state) north of New Mexico?

State name: Colorado

What is the number amount listed for this state?

Number amount: 89

10. What border state (touching state) is west of New Mexico?

State name: Arizona

What is the number amount listed for this state?

Number amount: 96

11. What border state (touching state) is north of Arizona?

State name: Utah

What is the number amount listed for this state?

Number amount: 80

12. You have now found the names of 11 states and the number amount of coal reserves. Find the names of the remaining numbered states and list them below:

(Order of answers will vary.)

State name: Oklahoma Number amount: 65

State name: Kansas Number amount: 56

State name: Iowa Number amount: 74

State name: Missouri Number amount: 90

State name: Illinois Number amount: 81

State name: Ohio Number amount: 70

State name: Maryland Number amount: 50

State name: West Virginia Number amount: 58

State name: Virginia Number amount: 47

State name: Kentucky Number amount: 64

State name: Arkansas Number amount: 75

State name: Indiana Number amount: 73

State name: Pennsylvania Number amount: 51

13. What state do we live in? California

Does our state have any coal reserves? No.

14. What is the state closest to California that has a large coal reserve that could be used as a source of energy?

Arizona

15. Now that you have finished this activity, share anything you have learned about coal reserves--an important source of energy in the United States. Use the space below to write out your answer.

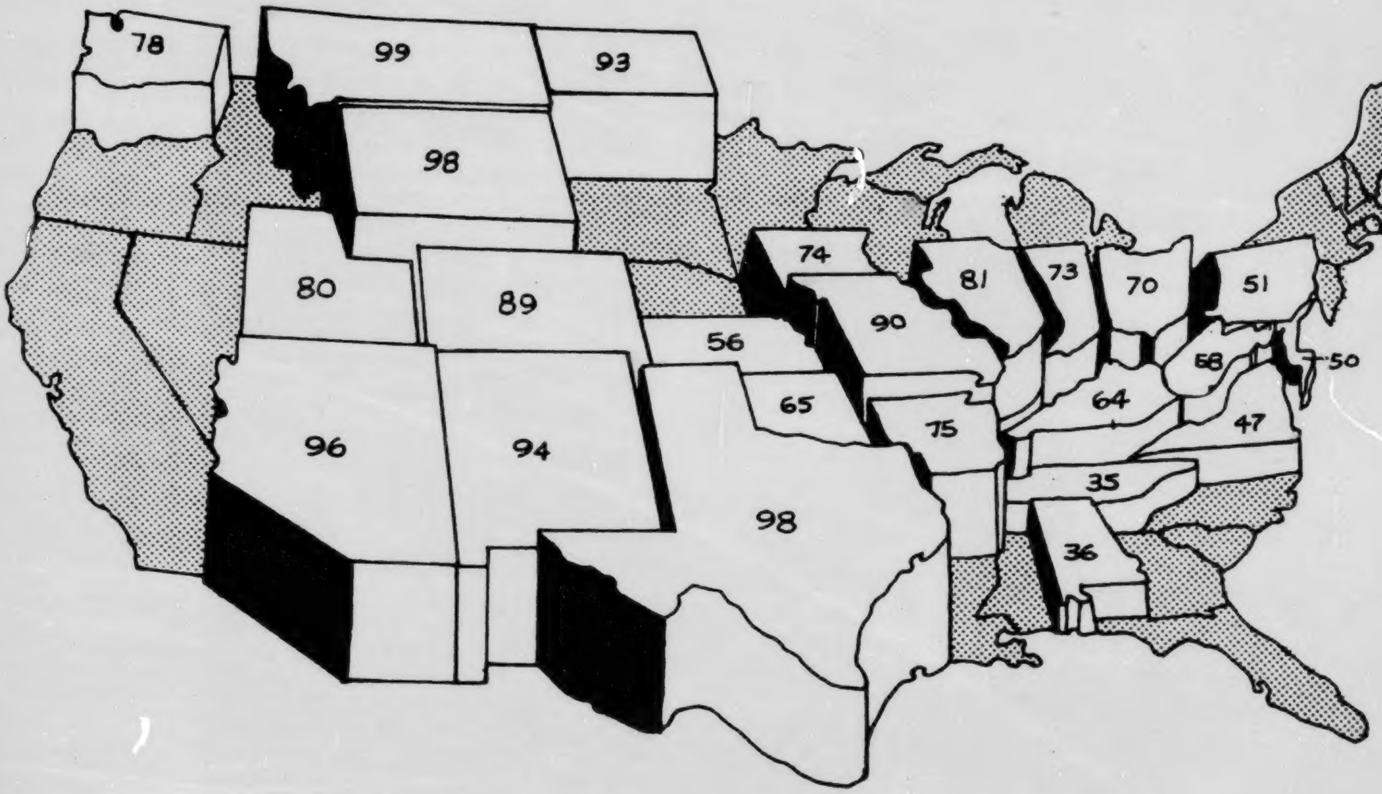
(Answers will vary.)

16. Name one advantage of using coal.

17. Name one disadvantage of using coal.

18. Make a statement about how you see coal as a future energy source.

U.S. COAL RESERVES
1977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ACTIVITY 27

Learning: The limited nature of our natural resources will change our future use of them.

Procedure: Tell children the following:

> The year is 2020. The much-hoped-for new energy sources talked about in the 1970's were not developed fast enough. The President of the United States has called a meeting of people who represent groups in our nation which depend on oil, either as an energy source or as a material used in industry.
>
> There are five groups in the President's first series of discussions. Their job as representatives is to convince the President that the group they represent should have the first chance to use what is left of the oil available to the United States.
>
> The groups represented are: (1) The transportation industry, which includes airlines, buses, trains, ships, (2) citizens who want to be able to drive their own cars, (3) the plastics industry, which depends on oil to make its products, (4) power companies, which need oil to provide the electrical energy our country needs, and (5) farmers, who need the oil to run the machinery as well as the fertilizers used to increase production.

Divide the class into five discussion groups. Each group will represent one of the five groups in the President's office. Their job is to brainstorm as many reasons as they can think of in a given time period why the President should allow the people they represent to get most of the remaining oil. Their reasons should be recorded by a secretary appointed by the group. Try to balance each group in terms of verbal ability as well as number of boys and girls.

At the end of the brainstorming session, bring the five groups together. The teacher will play the role of the President and preside over the meeting. The teacher should ask extending questions which would allow children to examine their reasons and explore alternatives. Example:

Student: I think the power companies should get the remaining oil because our country depends on electricity to light and heat our homes.

Teacher: What other energy sources could your power companies use to generate electricity (coal, nuclear energy, etc.)?

Teacher: What would be the effect of using other sources to generate electricity?

Evaluation: After listening to all of the arguments from each of the five groups, have the class decide who gets the lion's share of the remaining oil. NOTE: Tell students to keep in mind at this point that they are not just representing their own special interest group but should consider the welfare of the entire nation.

OBJECTIVE 5: *Students will recognize the need for all citizens to accept social responsibility in decisions about energy use.*

ACTIVITY 28

Learning: We are decision-makers.

Materials: "Who Makes Decisions?" activity sheet (Appendix A-41)

Teacher Information: A decision is a choice from among two or more alternatives. We spend our lives making decisions. Many of our decisions deal with trivial and routine matters. Others, however, deal with difficult new problems and matters of great importance to us and others.

Children, as well as adults, make decisions. Children decide such things as which television shows to watch, what clothes to wear, what comic books to buy, which friends to invite to parties, which side to take in arguments, whether or not to pay attention in class, whether to cover up or accept responsibility for previously anonymous wrongdoings, and many other things.

The purpose of this lesson is to help students discover that they make decisions. Many may not be aware that they do, in fact, make decisions. They may feel that decisions are something only adults make.

Procedure: Explain that decisions are all around us. Ask students what they think a decision is. You may want to have them look up the word in a dictionary. (A decision is a choice from among two or more alternatives.) Ask:

> How many decide whether to watch TV or play after school?
>
> How many decide what to do or play?
>
> How many decide what library books to read?

Have each student complete the "Who Makes Decisions?" activity sheet and compute his/her decision-making score. Explain that "yes" on the activity sheet means "mostly yes" and "no" means "mostly no." Allow students to compare answers and scores--either as a small group activity or using the chalkboard.

Make a class graph or chart (example below) to display the response to items on the activity sheet.

Example of chart:

Do you decide when to do your homework?	☺☺☺☺☺☺☺	7
Do you decide what clothes to wear to school?	☺☺☺☺☺	5
Do you decide what to eat for breakfast?	☺☺☺☺☺☺☺☺	8

Discuss the results. The chart will illustrate that *while everyone makes decisions, not everyone makes decisions about the same things.*

Evaluation: Have students list decisions they make regarding energy use. They may need to think a few minutes, and some questions may motivate their thinking.

> Do you decide whether or not to leave the light on in a room when you leave it?
>
> Do you decide whether or not to leave the door open when it's cold outside and the heat is on inside?
>
> Do you decide whether or not you leave water running in the sink while you make a sandwich?

Then ask:

> Who else makes decisions about energy use? (Parents, teacher, the president, etc.) What decisions do they make?

Conclude that people of all ages and in all kinds of positions are making decisions daily about the use of energy.

DECISIONS! DECISIONS! WHO MAKES DECISIONS?

Students your age make many decisions every day. How many decisions do you make? To discover your decision-making rating, answer each question below YES or NO.

1. Do you decide who you will play with after school? NO ☐ YES ☐
2. Do you decide what clothes to wear? NO ☐ YES ☐
3. Do you decide whether or not to pay attention to your teacher in class? NO ☐ YES ☐
4. Do you decide what games you play? NO ☐ YES ☐
5. Do you decide what you will buy with your own money? NO ☐ YES ☐
6. Do you decide what TV programs you will watch? NO ☐ YES ☐
7. Do you decide what time you will go to bed on school nights? NO ☐ YES ☐
8. Do you decide what time school starts in the morning? NO ☐ YES ☐

	Total NO	Total Yes
Add up your decision-making score.	☐	☐

ARE YOU A DECISION-MAKER?

ACTIVITY 29

Learning: Different groups of people think differently about conservation of energy.

Materials: "Same-o-Same-o" fable (Appendix A-42)

Procedure: Read the fable, "Same-o-Same-o." Discuss the story briefly, then divide the classroom into two groups: business persons and home owners. The two groups must think of ways for the town to cut down on energy consumption. Each group should list possible cuts, including new laws for future conservation. List on the board so that the differences can be seen. Have a spokesperson for each group explain their list.

Evaluation: Discuss the different points of view reflected. Discuss the reasons for the differences.

Have the two groups agree on which cuts will be more beneficial to *the town as a whole*. As a class, write an energy-saving policy for Same-o-Same-o.

SAME-O-SAME-O

A Fable

The town of Same-o-Same-o was secluded, far away from the rest of the world. In this town, everything was always the same. People drove the same car year after year after year. They wore the same clothes for years and did the same things in their leisure time. They never changed their life-style because the same way was always the right way. The townspeople always used the same amount of electricity, gas, and water. Same-o-Same-o had one gas line and one electric line coming from Big City 2,000 miles away. The town also had only one well which used an electric pump to supply the town's water.

Then one day J. P., the son of the mayor, came back to Same-o-Same-o after four years of college. He was the first citizen of Same-o-Same-o ever to go away to college. He had studied business and advertising.

The first thing J. P. did was set up a Business Consulting Agency for himself. He consulted first with the gas station businessmen. He convinced them that they should advertise so people would use their cars more. This would mean more gas sales for them.

The new car dealer was J. P.'s next visit. J. P. told the dealer that through advertising, he could convince people that they needed a big, new luxurious car. The plan would make lots of money for him.

The landscaping company of Same-o-Same-o was next. J. P. suggested that people should have more plants, bigger lawns, more outside lighting, and more outside gas barbecues. It was easy to convince people that more lights would be safer, more plants would be prettier, and outdoor entertaining would be more fun.

The manager of the hamburger stand was told he should update his packaging. Each item should be packaged separately so that the amount would look larger and the food would stay warmer. J. P. convinced them that this way could save by making the hamburgers smaller but the packaging bigger. Besides, he pointed out, packaging is only paper and plastic.

The general store owner was not left out of J. P.'s campaign. Trash compactors, electric mixers, curling irons, electric curlers, hair dryers, dishwashers, garbage disposals, washers, dryers, and electric toys were added to the store's inventory. The clothing store owner was encouraged to carry more clothes made of nylon so that they were wrinkle free. J. P. saw to it that swimming pools and Hot-Tub spas were promoted. Air conditioning was suggested for homes and businesses.

All over Same-o-Same-o, things began changing rapidly. People began buying big new cars and energy-gobbling appliances. Soon there were many swimming pools being installed. Giant green lawns were all around. Each business was air-conditioned and had a lighted sign that stayed on all night to advertise.

With Same-o-Same-o's one gas line and one electric line the town was now experiencing shortages. The city barely had enough electricity to pump water from its one well. The mayor called the townspeople together to discuss what should be done.

"We must cut down our use of energy," he said. "Maybe we shouldn't water our lawns or fill our swimming pools." "Boo," said the people with large lawns and new swimming pools. "Maybe we should cut down on the lighting for businesses and stop selling new cars," said the mayor. "Boo," said the businessmen.

The people of Same-o-Same-o didn't want to cut down because they were accustomed to their new way of life. The businesses didn't want to cut down because they were making so much money. Alas, such problems! Why are the people so unhappy, with so many problems, when before everyone was always happy about being the same?

ACTIVITY 30

Learning: Alternatives and consequences must be examined before decisions are made.

Teacher Information: This activity is designed to have students recognize that careful decision-making involves looking for several alternatives to the problem and then examining the possible consequences of each alternative before making a decision.

This activity was adapted from Sidney Simon's *Values Clarification.*

Procedure: Present some energy-related problem to the class and write it on the chalkboard. For example: "Ways to Save Gasoline in Our City" or "Ways to Save Electricity in Our City."

Allow three to five minutes for students to individually list as many alternative solutions to this problem as they can devise.

Have students form groups of four or five and, as a team, develop a list of alternatives to the problem by combining their individual lists. Additional alternatives may be added as the team prepares the list. When groups exhaust all the alternatives they can think of in 10 minutes, have them select the three alternatives they like best and rank-order these.

Each group should then report these three alternatives to the class. As each group reports, list the alternatives on the chalkboard.

Have students copy the class list from the chalkboard and think about each alternative to determine if it is something they would try, something they will think about, something they won't try, or something they cannot do.

Example:

	I'll try it	I'll think about it	I won't try it	I can't do it
1.				
2.				
3.				
4.				
5.				
6.				
7.				

If the "I can't do it" column is checked, discuss why it was checked and who could do it.

Have each student select the three alternatives from the list that seem the most feasible solution. List these three alternatives across the top of a paper with a column under each one:

Alternative 1	Alternative 2	Alternative 3

Under each alternative have students list as many possible consequences as they can think of. This can be done individually, in small groups, or using the brainstorm method.

After students have considered the consequences, ask them to reevaluate their original position. Reevaluation may be accomplished individually or as a small group or classwide activity.

Evaluation: When an alternative is selected as the best or most appropriate solution to the problem, have students consider this question: "If that is a good alternative, what is the first thing that should be done to accomplish it?"

Extended Activity: This activity, "Alternatives Search" and "Consequences Search," could be repeated several times throughout the study of energy and the environment. Each time a different problem could be examined.

ACTIVITY 31

Learning: Decisions about energy should be made rationally.

Materials: Chalkboard, chalk

Teacher Information: This activity is designed to give students a decision-making tool. It is a graphic representation of the forces compelling an individual or group and of the forces restraining them. By comparing these two opposing influences, decisions can be made more rationally.

This activity was adapted by Nick King from Sidney Simon's *Values Clarification.*

Procedure: Choose an energy-related topic on which a decision should be made. For example:

Should people drive cars with smaller engines?
Should the 55 mph speed limit be obeyed?
Should large cities develop mass transit systems?
Should beverages be sold in returnable containers?

On the chalkboard, list the topic and divide into forces. Examples:

OIL DRILLING OFF SAN DIEGO COAST		
Environmental	Industrial	Personal

NUCLEAR POWER PLANT CONSTRUCTION	
Forces Compelling	Forces Restraining

Have students brainstorm and list items in each column, then compare the two columns, taking the strength of each force into account. (If lists seem incomplete, the teacher may find it necessary to add items.)

Organize each list, grouping similar items together or relating items in the order of their importance to various types of decision-makers.

Evaluation: Organize the class into small groups, with each group focused on one of the decision-making perspectives (car owners, marine biologist, oil company executives, etc.). Have each group compose and read to the class a statement outlining its stand on the issue.

ACTIVITY 32

Learning: Good decisions can be made only after adequate input.

Materials: "Sources of Energy Materials" (Appendix A-43)

Teacher Information: A contributor to many of the energy-related environmental problems facing us today is the number of decisions that are being made without adequate information or knowledge. When an individual does not have enough data regarding a problem, the solution often becomes a simplistic "Well, all they have to do is...."

This activity is designed to help students appreciate the need for information before making decisions and to make them aware of *where* and *how* to get information on energy.

Procedure: Tell students that by some phenomenon the earth's salt deposits are dissolving rapidly and that for some reason no new salt is being replaced in the earth. This presents an immediate shortage of salt to people and poses a critical problem for the future.

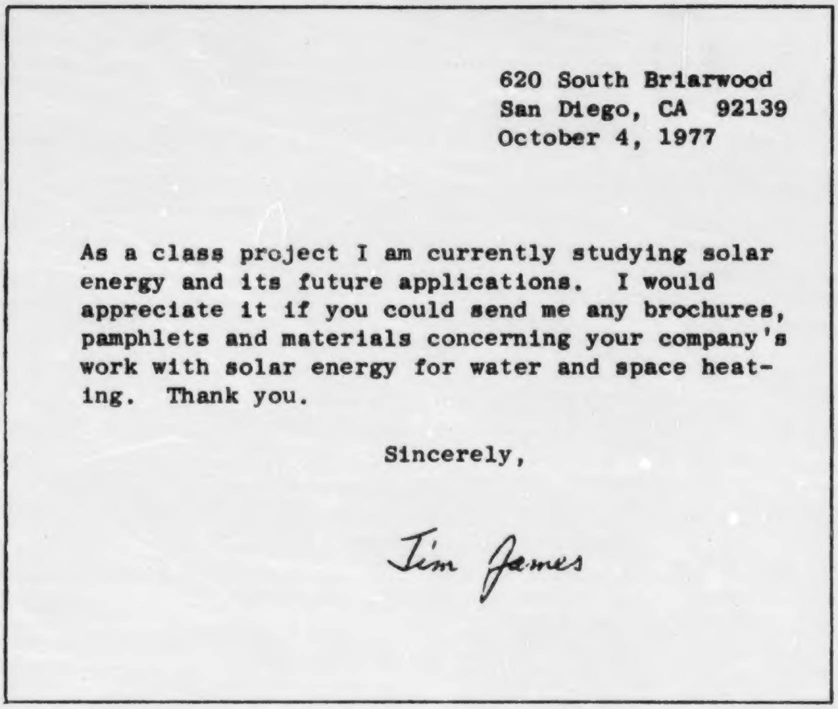
Have students react to this situation by writing a story, a poem, or a report. What changes will take place in their lives? How will they cope with the diminishing supply of salt? How will they plan for alternatives for this important resource for the future?

Have students relate how it felt to write about something for which they had limited information.

Explain to students the importance of gathering information from *several* sources before making decisions regarding energy-related problems.

Have each student select one of the agencies on the list, "Sources of Energy Materials," and write a letter requesting specific energy materials. (See example on next page.)

Before the letters are written, discuss the format and the content of the letters. Be sure students are precise in their requests, and check all the letters for clarity and good taste as well as the usual punctuation, spelling, grammar, etc.



620 South Briarwood
San Diego, CA 92139
October 4, 1977

As a class project I am currently studying solar energy and its future applications. I would appreciate it if you could send me any brochures, pamphlets and materials concerning your company's work with solar energy for water and space heating. Thank you.

Sincerely,

Tim James

Evaluation: As materials are reviewed, have them presented to the class. In a class discussion examine the bias of the source in each case and how it is reflected in the material. Stress the need for being aware of bias as you gather information for making good decisions. When most of the materials are in, look for the various points of view they reflect and apply this knowledge to a decision-making activity.

SOURCES OF ENERGY MATERIALS

American Gas Association
1515 Wilson Blvd.
Arlington, VA 22209

American Nuclear Society
San Diego Chapter
P.O. Box 81451
San Diego, CA

American Nuclear Society
National Office
244 East Ogden Ave.
Hinsdale, IL 60521

American Petroleum Institute
1801 "K" Street NW
Washington, DC 20006

American Public Power Association
2600 Virginia Ave. NW
Washington, DC 20037

Atomic Industrial Forum
475 Park Ave. South
New York, NY 10016

Citizens' Advisory Committee on
Environmental Quality
1700 Pennsylvania Ave. NW
Washington, DC 20006

Ecology Forum
124 East 39th Street
New York, NY 10016

Edison Electric Institute
90 Park Ave.
New York, NY 10016

Thomas Alva Edison Foundation
Cambridge Office Plaza, Suite 143
18280 West Ten Mile Rd.
Southfield, MI 48075

Electrical Industries Association
6055 E. Washington Blvd.
Los Angeles, CA 90040

Energy Conservation Research
9 Birch Road
Malvern, PA 19355

Energy Information Center
100 California St.
San Francisco, CA 94111

Energy Research and Development Adm.
Department of Energy
Office of Public Affairs
Washington, DC

Environmental Action Foundation
724 Dupont Circle Building
Washington, DC 20036

EXXON, USA
Public Affairs Department
P.O. Box 2180
Houston, TX 77001

Federal Energy Administration
Department of Energy
111 Pine St.
San Francisco, CA 94111

Foundation for Alternative Energy
407 N. Maple Drive
Beverly Hills, CA 90210

Interstate Oil Compact Commission
Educational Department
P.O. Box 53127
Oklahoma City, OK 73105

National Audubon Society
1412 - 16th Street NW
Washington, DC 20036

National Coal Association
1130 - 17th St. NW
Washington, DC 20036

National Interviews
153 "E" Street SE
Washington, DC 20003

National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, MD 20850

San Diego Ecology Centre
340 Kalmia St.
San Diego, CA 92101

San Diego Gas and Electric
P.O. Box 1831
San Diego, CA 92112

Scientists' Institute for Public Information
30 East 68th Street
New York, NY 10021

Shell Oil Company
Public Affairs
P.O. Box 2463
Houston, TX 77001

Sierra Club
1051 Mills Tower
San Francisco, CA 94104

Sierra Club, San Diego Chapter
1519 El Prado
San Diego, CA 92101

Solar Energy Research Institute
Department of Energy
Golden, CO

State Energy Resources Conservation
and Development Commission
1111 Howe Ave.
Sacramento, CA 95825

U.S. Department of Interior
18th and "C" Street NW
Washington, DC 20240

U.S. Environmental Protection Agency
401 "M" Street SW
Washington, DC 20240

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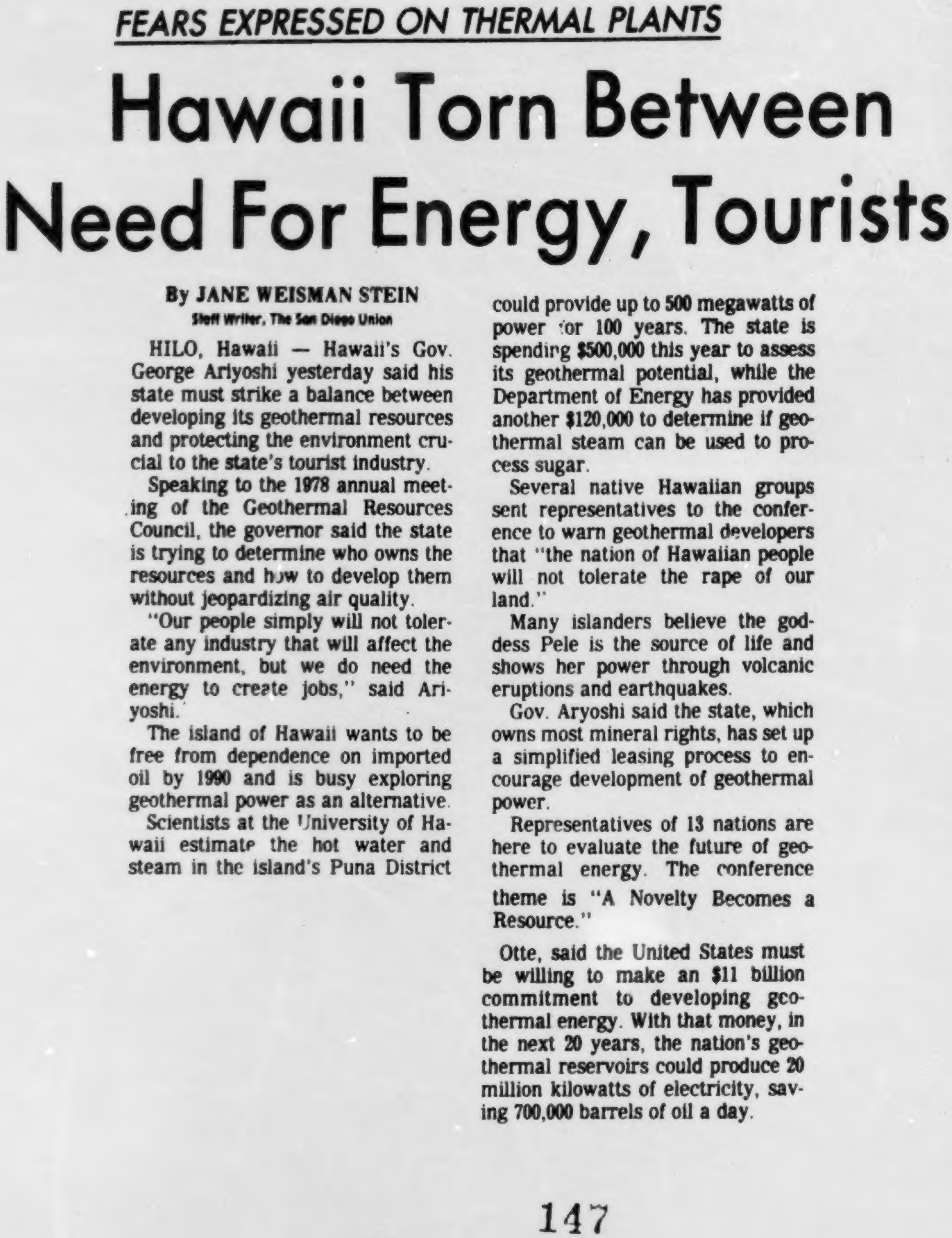
ACTIVITY 33

Learning: Decisions must be made by groups of people.

Materials: Newspaper article, "Hawaii Torn Between Need For Energy, Tourists"

Procedure:



FEARS EXPRESSED ON THERMAL PLANTS

Hawaii Torn Between Need For Energy, Tourists

By JANE WEISMAN STEIN

Staff Writer, The San Diego Union

HILO, Hawaii — Hawaii's Gov. George Ariyoshi yesterday said his state must strike a balance between developing its geothermal resources and protecting the environment crucial to the state's tourist industry.

Speaking to the 1978 annual meeting of the Geothermal Resources Council, the governor said the state is trying to determine who owns the resources and how to develop them without jeopardizing air quality.

"Our people simply will not tolerate any industry that will affect the environment, but we do need the energy to create jobs," said Ariyoshi.

The island of Hawaii wants to be free from dependence on imported oil by 1990 and is busy exploring geothermal power as an alternative.

Scientists at the University of Hawaii estimate the hot water and steam in the island's Puna District could provide up to 500 megawatts of power for 100 years. The state is spending $500,000 this year to assess its geothermal potential, while the Department of Energy has provided another $120,000 to determine if geothermal steam can be used to process sugar.

Several native Hawaiian groups sent representatives to the conference to warn geothermal developers that "the nation of Hawaiian people will not tolerate the rape of our land."

Many islanders believe the goddess Pele is the source of life and shows her power through volcanic eruptions and earthquakes.

Gov. Aryoshi said the state, which owns most mineral rights, has set up a simplified leasing process to encourage development of geothermal power.

Representatives of 13 nations are here to evaluate the future of geothermal energy. The conference theme is "A Novelty Becomes a Resource."

Otte, said the United States must be willing to make an $11 billion commitment to developing geothermal energy. With that money, in the next 20 years, the nation's geothermal reservoirs could produce 20 million kilowatts of electricity, saving 700,000 barrels of oil a day.

Explain to students that, not only do individuals make decisions about energy and its impact on the environment, decisions must be made at the city, state and national level, also. Discuss the fact that the decisions that are made reflect the values of the person or the group.

Read the newspaper article, "Hawaii Torn Between Need For Energy, Tourists."

Ask what values are evident in this article. List these on the board.

Ask students which one they feel is the most important.

Ask if there seems to be a "value conflict" within the list. After one is identified, ask why this would be a conflict.

Evaluation: Have students write a paragraph exploring the value conflict between the need for more and more energy and the opposition to nuclear power plants in California.

APPENDICES

To accompany Activity 1 Appendix A-1

QUESTIONS

(Begin at the triangle.)

1. A source of energy is considered nonrenewable if no more of it can be produced or if it takes so long that we can't wait.

   If this is true, move up.
   If this is false, move down.

2. Forces can be natural or man-made. An example of a natural force is wind.

   If this is true, move up.
   If this is false, move down.

3. A force always does work. (scientific definition)

   If this is true, move up.
   If this is false, move down.

4. Moving (mechanical) energy can change into sound, heat, and/or light energy.

   If this is true, move up.
   If this is false, move down.

   The letter is ☐ (1)

   Begin again at the triangle. Move up on the gameboard for true statements, move down for false statements.

5. Plants and animals can convert and store energy directly from the sun.

6. Energy can be transferred to make other things move.

7. A battery, a potato, and coal all are examples of stored energy.

8. Combustion releases energy stored in organic materials.

   The letter is ☐ (2)

   Begin again at the triangle.

9. The energy stored in fuel is in the form of mechanical energy.

10. Kilowatt hours are units used in measuring natural gas consumption, therms are used in measuring electricity consumption.

11. Fusion releases nuclear energy by splitting atomic nuclei.

12. Electrical energy can be converted to heat energy, light energy, or mechanical energy.

    The letter is ☐ (3)

Begin again at the triangle.

13. The energy in moving water is not related to solar energy.

14. Food has the sun's energy stored in it.

15. The sun is the source of energy for winds.

16. Nuclear energy cannot be used to make electricity.

The letter is ☐ (4)

Begin again at the triangle.

17. Through photosynthesis, a tree can change the energy in sunlight to chemical energy.

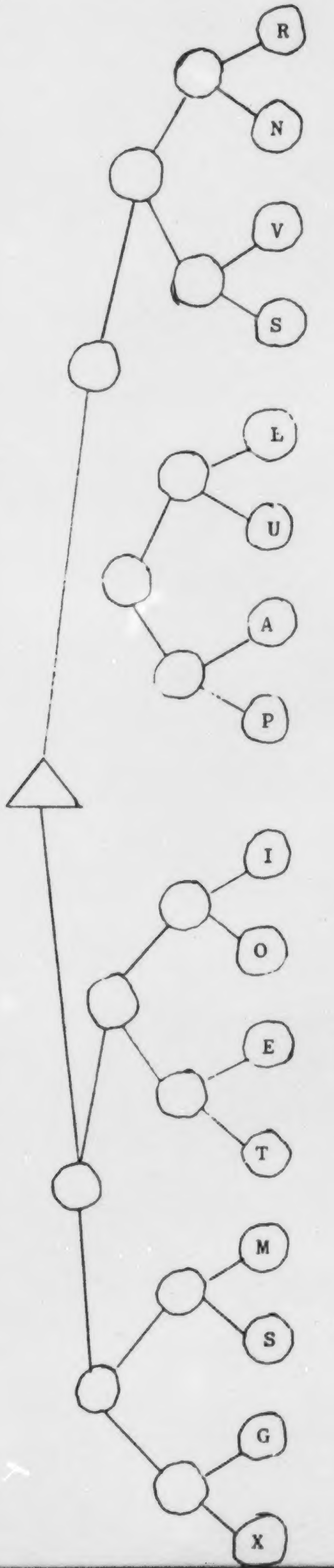
18. Fuels are commonly used to supply heat energy to produce electricity.

19. Fission and fusion are methods to release nuclear energy.

20. Cosmetics, drugs, dyes, fabrics, fertilizer, paints, styrofoam packing are all petroleum chemical products.

The letter is ☐ (5)

Name ______________________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N
V
S
L
U
A
P
I
O
E
T
M
S
G
X

To identify each letter, begin at the triangle. If the statement is true, move up. If the statement is false, move down.

☐	☐	☐	☐	☐
1	2	3	4	5

To accompany Activity #2

ENERGY

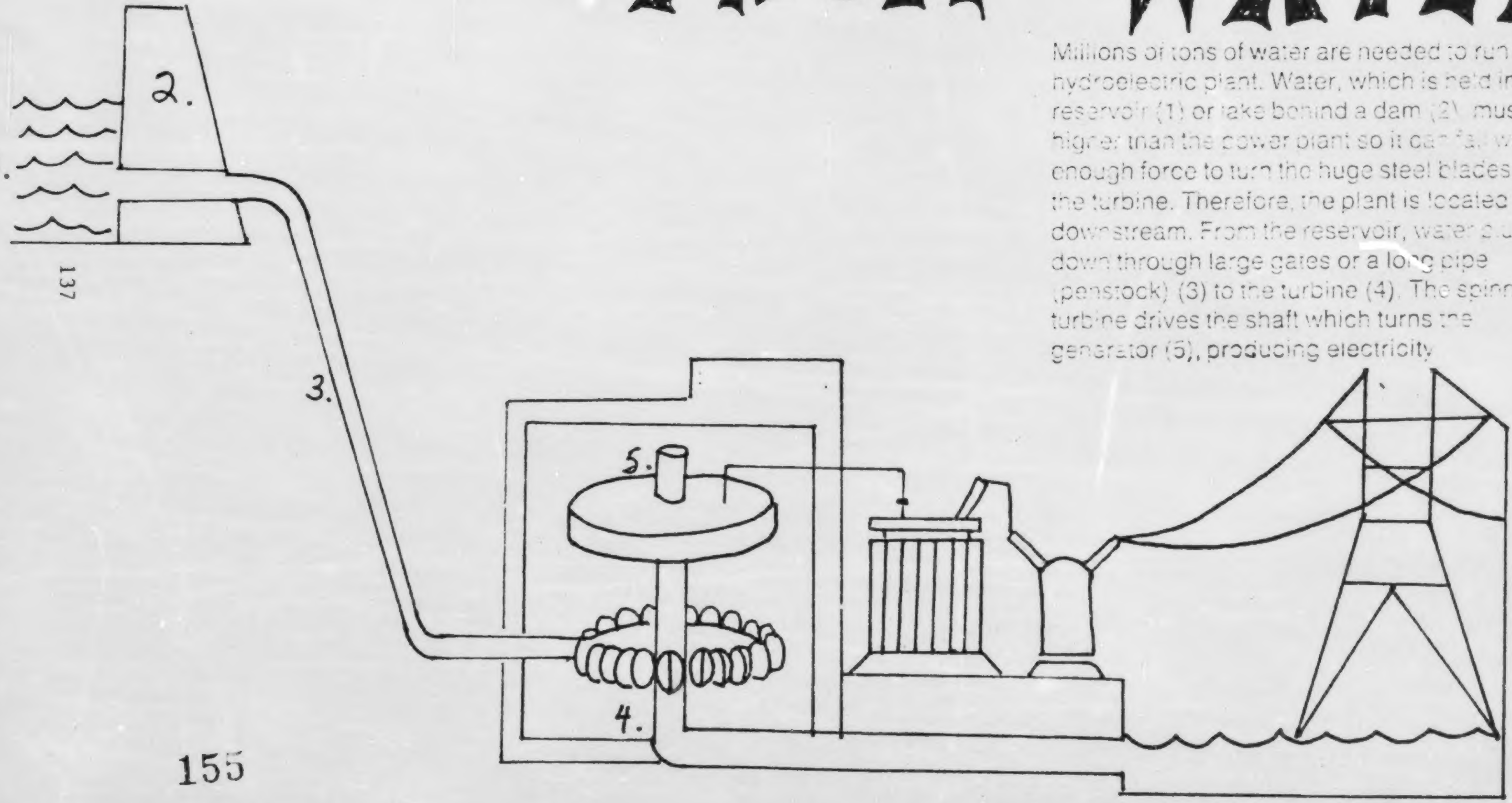
Phenomenon	Observed Effects (of energy use)	Form of Energy	Sources		
			Immediate	Intermediate	Primary

Appendix A-3

ELECTRICITY FROM WATER

Millions of tons of water are needed to run a hydroelectric plant. Water, which is held in a reservoir (1) or lake behind a dam (2), must be higher than the power plant so it can fall with enough force to turn the huge steel blades of the turbine. Therefore, the plant is located downstream. From the reservoir, water plunges down through large gates or a long pipe (penstock) (3) to the turbine (4). The spinning turbine drives the shaft which turns the generator (5), producing electricity.

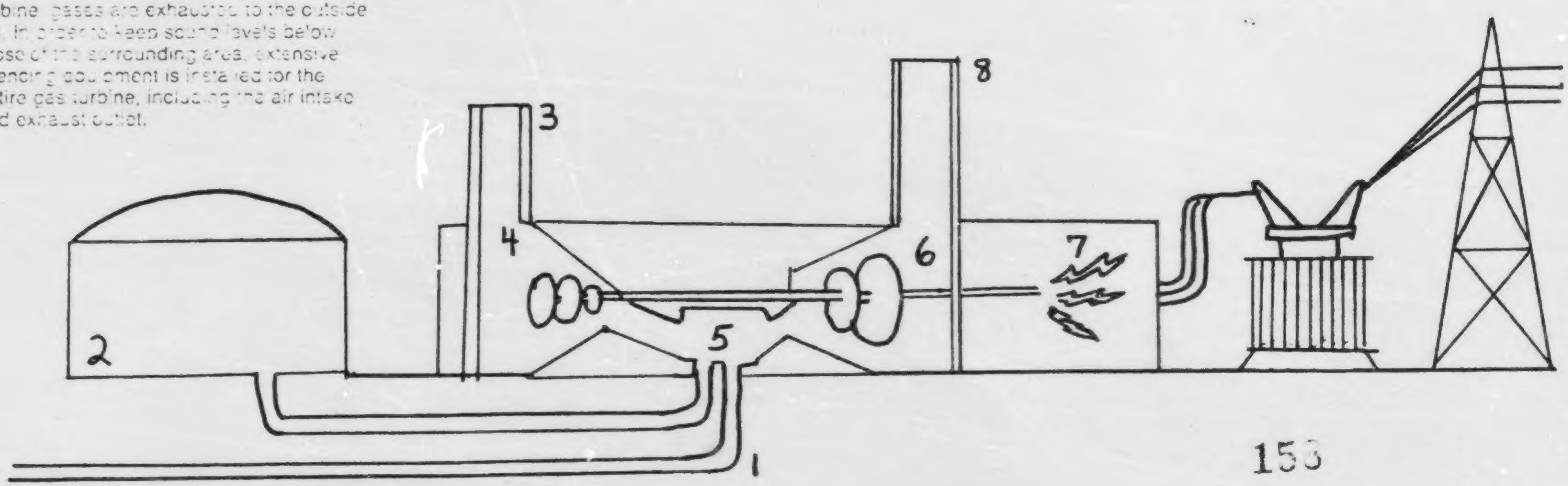
To accompany Activity 2



Appendix A-4

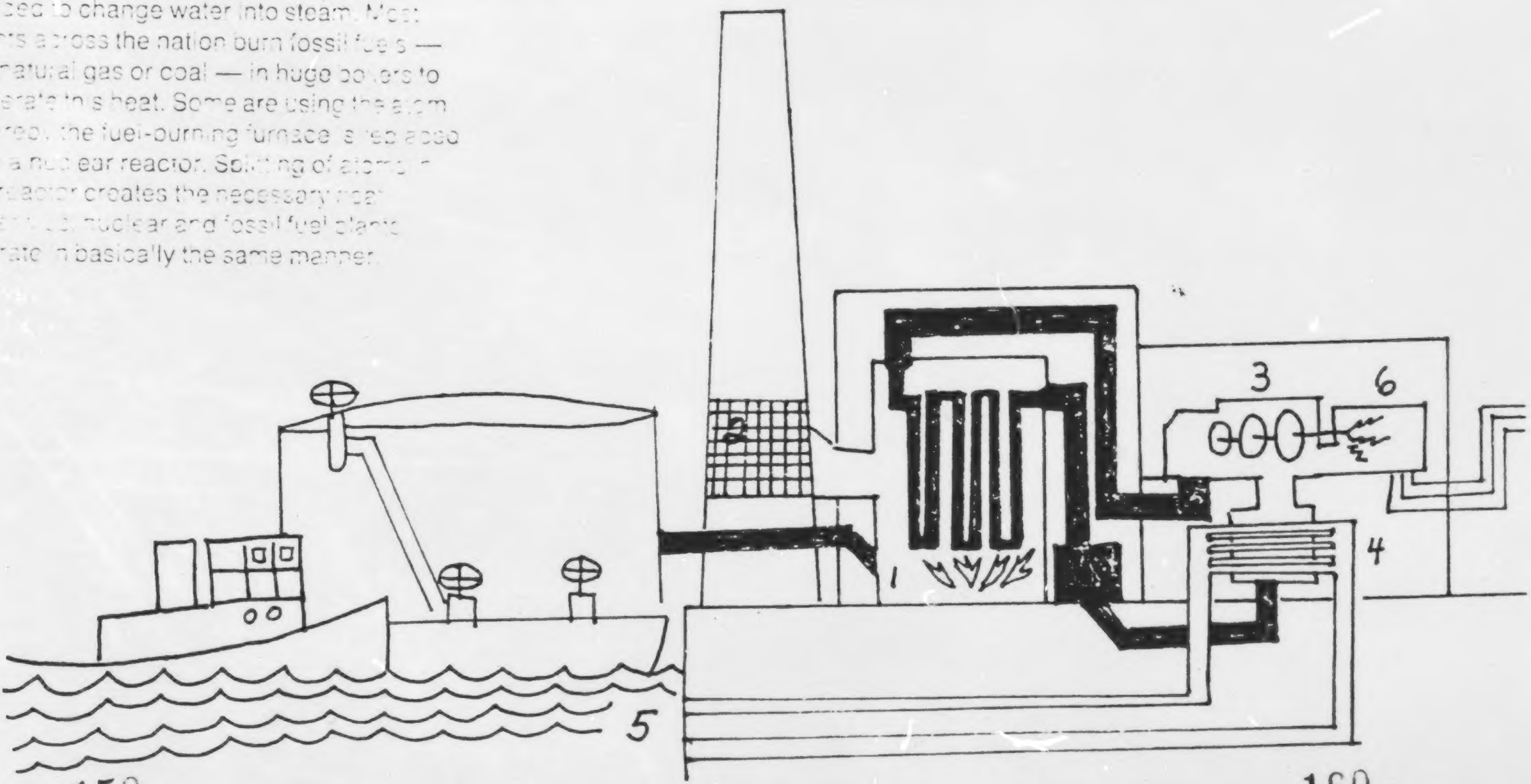
ELECTRICITY FROM GAS TURBINES

A gas turbine burns either natural gas supplied from a pipeline (1) (where available), or low-sulfur household-type oil which is delivered by truck or barge and stored in a tank (2). Air, drawn from the outside (3), is compressed (4), and discharged into combustion chambers (5). Here, fuel is added, mixed with the air and burned. Burning process produces high-pressure combustion gases, which flow to the turbines (6). Pressure of the gases rotates the turbine, which turns an electric generator (7). After passing through the turbine, gases are exhausted to the outside (8). In order to keep sound levels below those of the surrounding area, extensive silencing equipment is installed for the entire gas turbine, including the air intake and exhaust outlet.

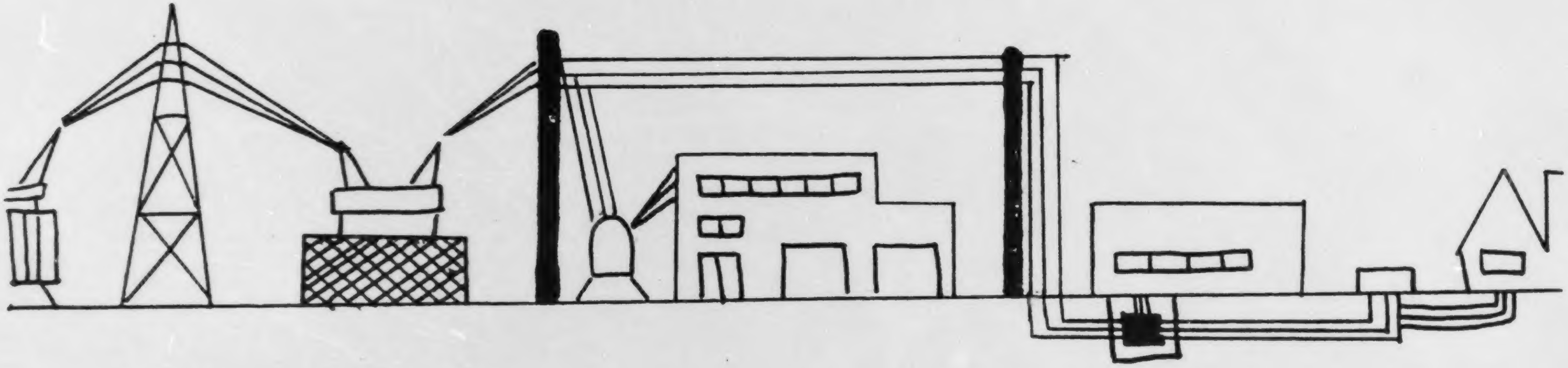


ELECTRICITY FROM FOSSIL FUELS

In steam-electric power plants, heat is needed to change water into steam. Most plants across the nation burn fossil fuels — oil, natural gas or coal — in huge boilers to generate this heat. Some are using the atom whereby the fuel-burning furnace is replaced with a nuclear reactor. Splitting of atoms in the reactor creates the necessary heat. Otherwise, nuclear and fossil fuel plants operate in basically the same manner.



Fuel is delivered to plant and stored in yard. Oil or finely powdered (pulverized) coal is blown into the boiler (1) where it burns, giving off intense heat. Water, circulating through miles of tubing in the boiler, absorbs heat from the fire and changes into steam. Ash resulting from the fuel burning in high-pressure boilers is removed from the stack gases by dust collectors (precipitators) (2). This permits clean gases to be released to the atmosphere, thereby reducing air pollution. Steam passes through the turbine (3) and into a condenser (4) where it is cooled and changed back into water as it flows over thousands of tubes. Water is then returned to boiler for reuse in the system. Water to condense steam is drawn from the body of water on which the plant is located (5), pumped through tubes in the condenser and returned to its original source. The turbine consists of a number of rows of blades which, much like spokes on a wheel, stem out from a shaft at the center. Steam acting against these blades, like wind on a windmill, causes the shaft to spin; its exact speed is controlled by a governor. Shaft turns the generator (6) which has two parts: a stationary part, coils of wire (stator); a rotating part, a magnet (rotor). Magnet rotates inside coils of wire. As the magnetic field moves at high speed past the coils of wire, alternating current is generated. Electricity then goes to a substation (7) outside the plant where transformers raise the voltage (electrical pressure) high enough to send the power many miles. Large cables (transmission lines) (8) suspended on steel poles or towers carry the current to substations (9). Here the voltage is lowered and electricity is fed into a distribution system (10). Smaller transformers provide proper voltages for industries, stores, homes and farms. After it reaches the customer, electricity goes through a meter which measures the amount being used.

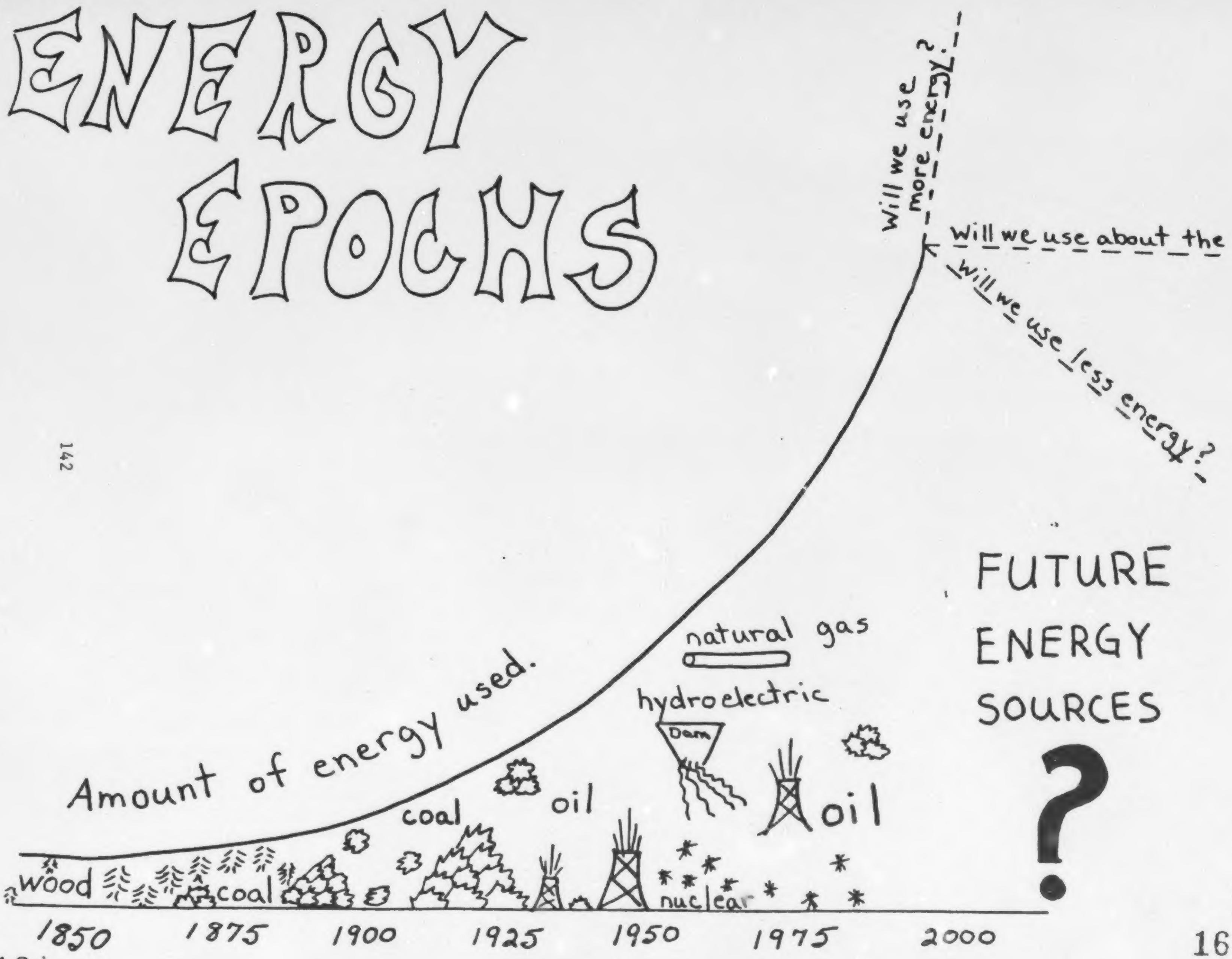


ENERGY WORD SEARCH

```
R E F I N E P E R T C N O I T S U B M O C
A Q F D R P M E U P L A M R E H T O E G P
M A T T H H E W O W T Y L H I S I S A E F
E F O L A O C T T T F G T R E E N O T L O
R C E B E T E S R O R R H E M R G R H E R
W T T A W O L I K O E E N C E N O D E C C
R I T H Y S T H G I L N A M A C E B R T I
W O R K O Y B N D S T E A T H Y L T M R R
U R T A N N R O C S Y F U E L A I H I I T
R E D C Y T O I A S T R M M M S S S T C C
E S T L A H P S A E A I F R A T S I N I E
F O O T A E H U M L C O E O N O O H O T L
S U U R O S R F G A R H A N D I F E I Y E
N R F F S I O A L C T T H G I L N U S W O
A C A P R S S N E I E S L I R A L O S E R
R E N E W A B L E M K E I K I N E T I C D
T I N G L T S O I E C A L O R I E S F V Y
Y O U L A C I N A H C E M W I L L L E A H
D O M I T H U K I C O N S E R V A T I O N
N T I P O T E N T I A L E L L E N I N G H
N D I N I N C A N D E S C E N T D E O L A
```

1. ASPHALT
2. ENERGY
3. PETROLEUM
4. HEAT
5. LIGHT
6. FISSION
7. FUSION
8. NUCLEAR
9. MECHANICAL
10. CHEMICAL
11. CALORIES
12. COAL
13. PETROCHEMICAL
14. POTENTIAL
15. KINETIC
16. REACTOR
17. RENEWABLE
18. NATURAL GAS
19. PHOTOSYNTHESIS
20. KILOWATT
21. SUNLIGHT
22. SOLAR
23. THERM
24. FOSSIL
25. TON
26. FUEL
27. REFINE
28. CONSERVATION
29. TRANSFER
30. COMBUSTION
31. ELECTRICITY
32. FORCE
33. THERMAL
34. WORK
35. HYDROELECTRIC
36. GEOTHERMAL
37. RESOURCE
38. INCANDESCENT

ENERGY EPOCHS



To accompany Activity 3

Appendix A-6

To accompany Activities 3, 4 and 6

Appendix A-7

RESEARCH GUIDE

1. Topic for research: ____________________

2. Use the index of books to find page numbers that will give you information. Write them: ____________________

3. Read the pages in the first source. Summarize each page.

4. Repeat for each source.

5. What is the main idea of what you read? ____________________

6. If there is a picture or chart that will help explain the information, draw it on a piece of large paper.

7. Think of how you can present your ideas to the class so they will understand what you found.

THE WORLD'S AIR

The air that you breathe keeps you alive. It does not belong to you. You only use it for a time and it then moves on to keep someone else alive. The air in our world belongs to all living things that need it to stay alive. We do not get "new" air. Instead, we use the same air over and over.

Air is always moving. It moves indoors and outdoors. Air movements, called air currents, move air from one place to another. The air that we use in our city today will be the air in another city tomorrow.

Answer these questions:

1. Give two examples that tell you that air moves.

   ____

   ____

2. Define *pollution*. (Use a dictionary.)

   ____

   ____

3. Tell in your own words what air pollution would be.

   ____

   ____

4. If a ship 10 miles out to sea is polluting the air, how could that affect the air you breathe?

   ____

   ____

5. Why would the people of a city be concerned with the smoke from a factory 20 miles away?

   ____

   ____

6. How does traffic affect our air?

   ____

   ____

7. Why should all people in our world be concerned with our air?

____

____

8. Name three ways you have used our air today.

____

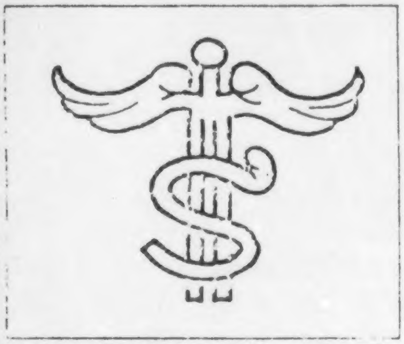
____

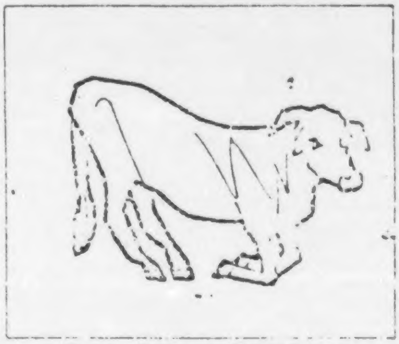
____

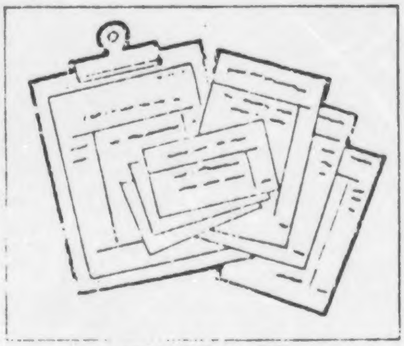
To accompany Activity 9

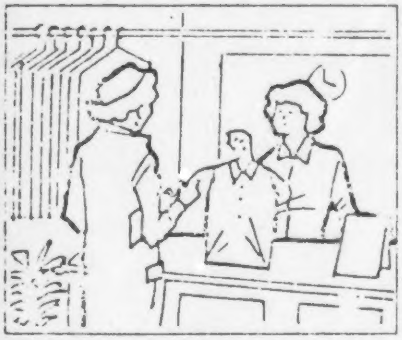
Appendix A-9

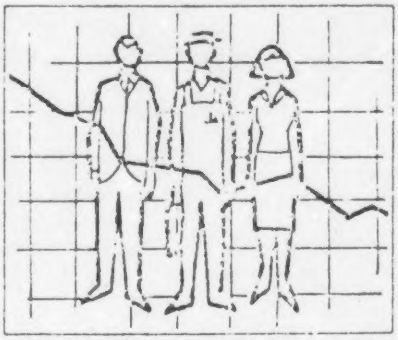
Dollar Cost of Air Pollution

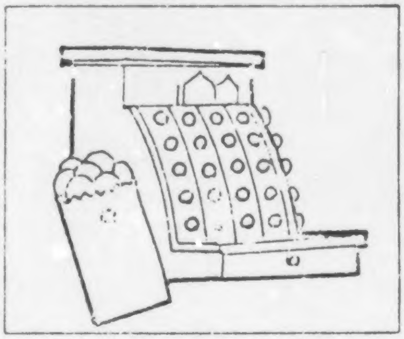

HIGHER MEDICAL COSTS

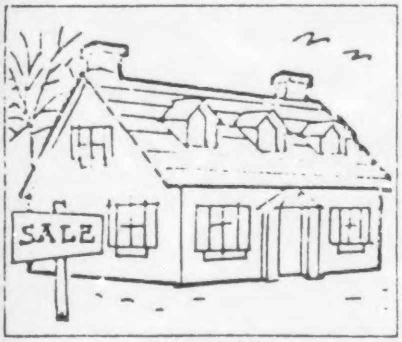

LOSS OF LIVESTOCK


INCREASED MAINTENANCE COSTS

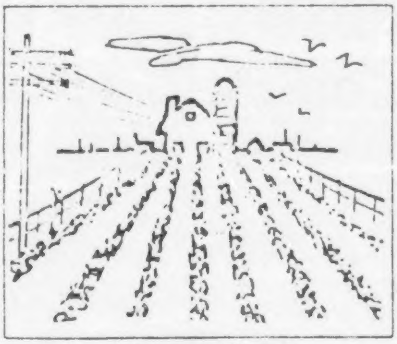

HIGHER CLEANING COSTS

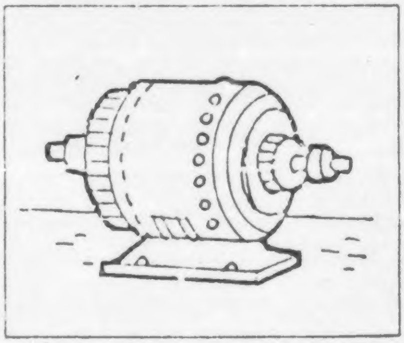

GREATER ABSENTEEISM


HIGHER FOOD BILLS



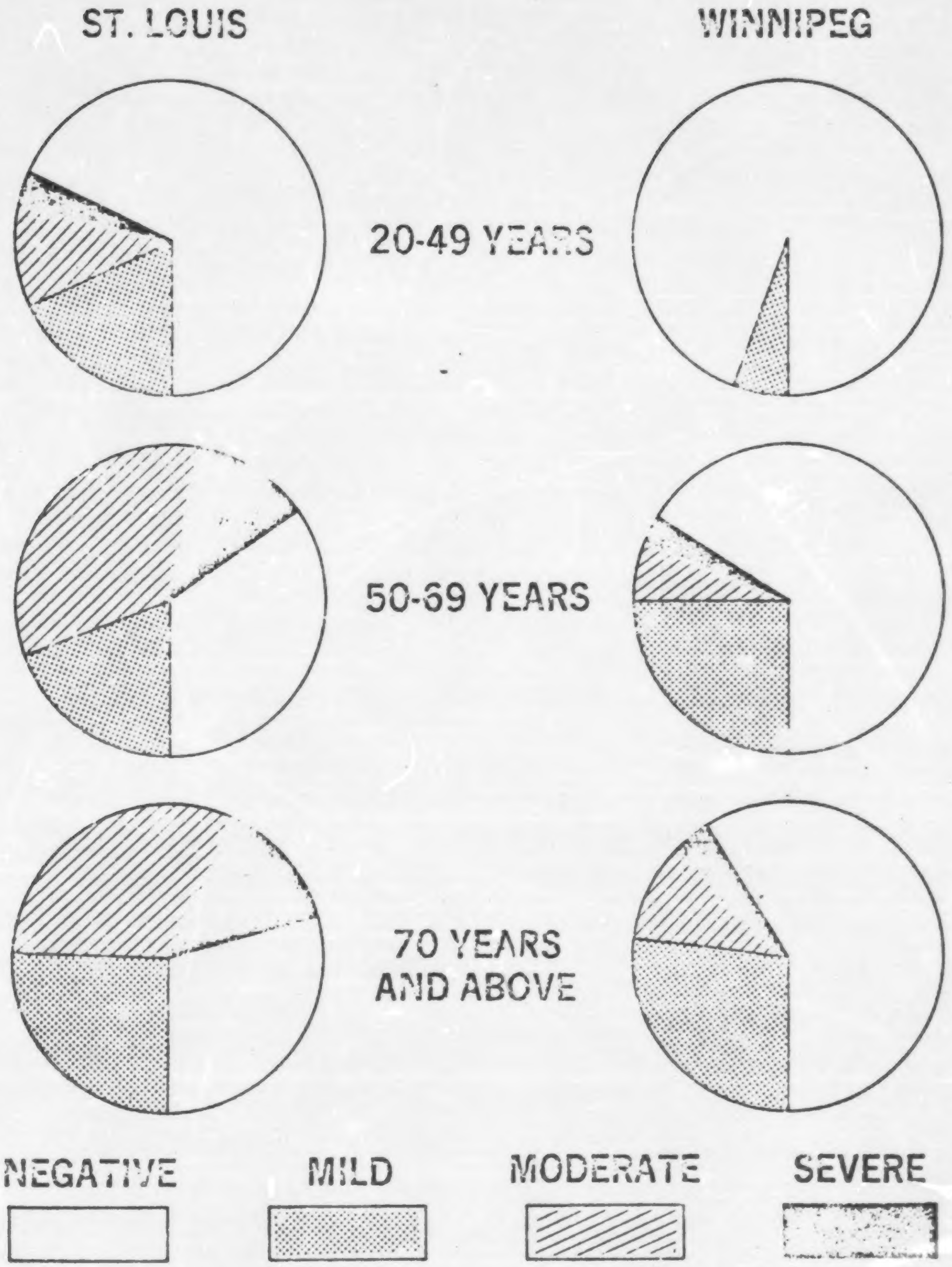
LOWERED REAL ESTATE VALUES


REDUCED OR DESTROYED CROPS

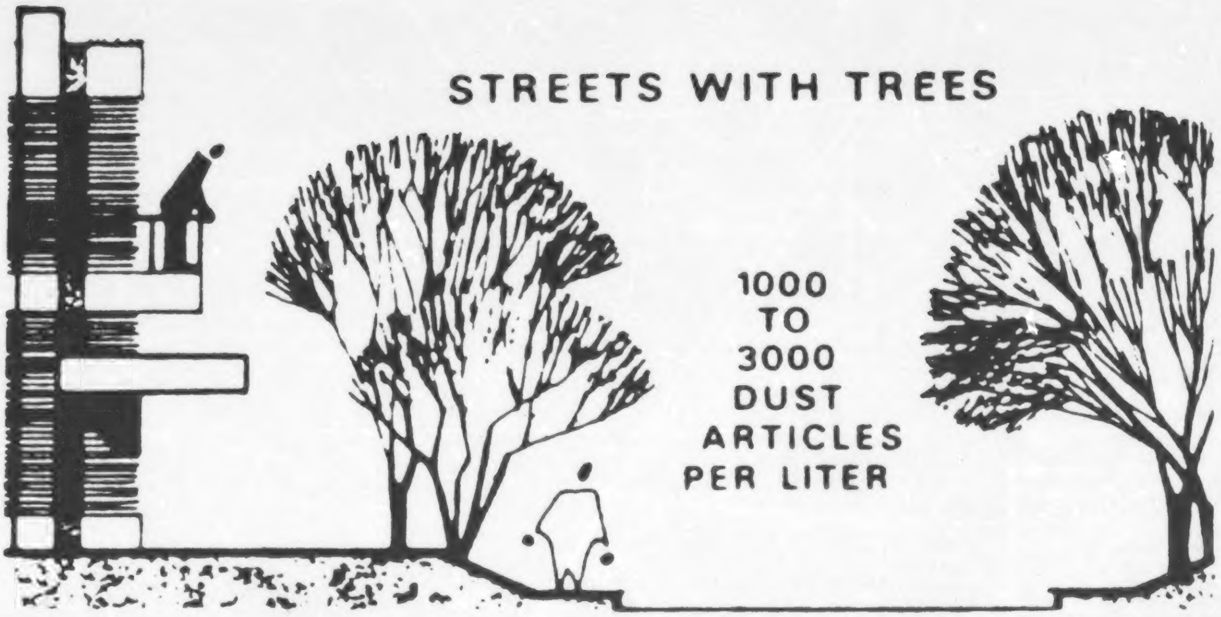

COSTLIER EQUIPMENT

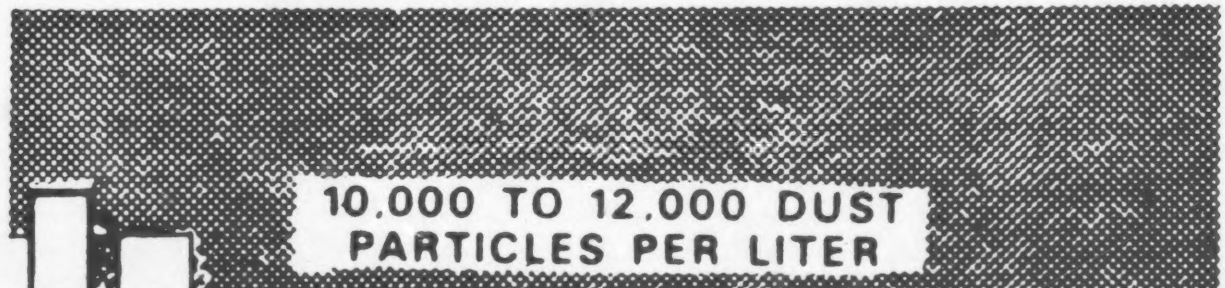
COURTESY NATIONAL TUBERCULOSIS AND RESPIRATORY DISEASE ASSOCIAT

HEALTH COST OF AIR POLLUTION



BY NATIONAL TUBERCULOSIS AND RESPIRATORY DISEASE ASSOCIATION


STREETS WITH TREES
1000
TO
3000
DUST
ARTICLES
PER LITER


10,000 TO 12,000 DUST
PARTICLES PER LITER
STREETS
WITHOUT TREES

THE GREAT GEARLOOSE CREATION

If you have an imagination, you will have fun with this. Just let your creativity run wild!

Imagine that you are Gotta Gearloose, a scientist and inventor who lives in the town of Fairview. Many citizens in your town have complained to the mayor that the air in Fairview is not as clean as it used to be. Because he is running for reelection, the mayor, Mr. Win D. Bag, has decided to do something about the problem (immediately, if not sooner!). He has decided to ban all automobiles as a form of transportation. He has asked you, Gotta Gearloose (world-famous inventor), to design a new form of transportation that will not pollute the air. Your plan is due at the end of this period. (This is a rush order--election is next week!)

Think about these questions before you begin:

1. What kind of energy will your new form of transportation use?
2. Will it go on land, in the air, on water, underground, or all four?
3. How many people will it carry?
4. How big will it be (size-wise)?
5. What will it look like?
6. How fast will it go?
7. How safe is it?
8. How often will it need to be repaired?
9. What will you name your creation?

Draw a picture of your pollution-free form of transportation and write a paragraph describing it.

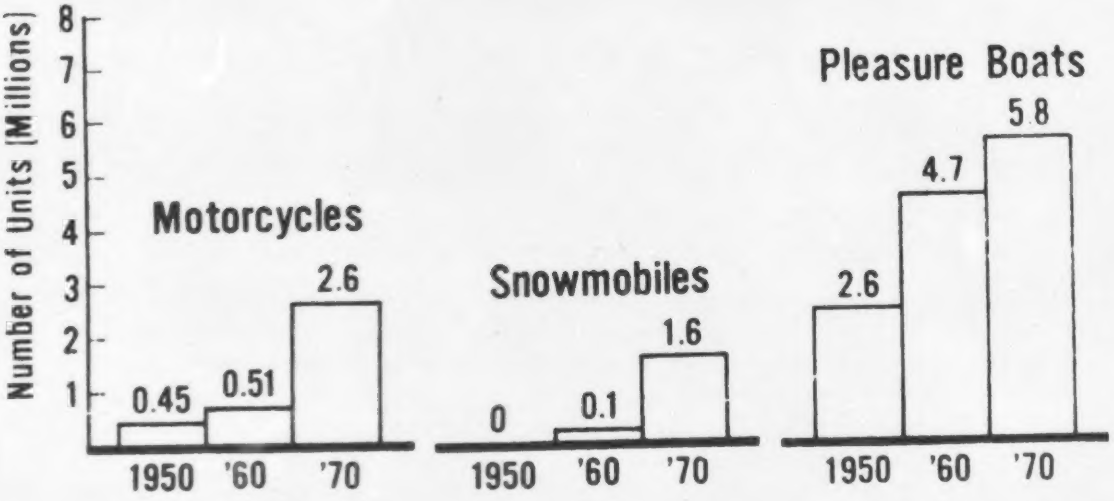
NOISE LEVELS IN DECIBELS:

	200	Noise Weapon
	190	
LETHAL LEVEL	180	
	170	
	160	
	150	Jet Aircraft at 200 feet
	140	
	130	Pneumatic Riveter; Air Raid Siren
THRESHOLD OF PAIN (one trillion times greater than least audible sound)	120	
	110	Rock Music with Amplifiers (4 to 6 feet away); Power Mower
	100	Food Blender (2 to 4 feet away) Motorcycle Subway Train
	90	Sports Car; Heavy Truck
DANGER LEVEL	80	
	70	Busy Street
	60	Normal Conservation
	50	Quiet Street, Average Urban Interior
	40	Quiet Room, Residential Area at Night
	30	Tick of Watch (at 2 feet)
	20	Whisper
	10	Leaves Rustling in Wind
THRESHOLD OF HEARING	0	

RECREATIONAL NOISE

The use of recreational vehicles has grown in the past 10 years. Improved design is producing lower noise levels. Use these charts to answer the questions.

GROWTH OF RECREATION VEHICLES



RECREATIONAL NOISE

1. What do the three bar graphs, "Growth of Recreational Vehicles," show?

____

2. What three recreational vehicles do the bar graphs represent?

____

3. Which of the three had the largest number in 1950? ______________

4. Which had the least? ______________________

5. Which of the three had the largest number in 1970? ______________

6. Which had the least? ______________________

7. Why do you think that is true? ____________________

____

8. Why do you think there is such an increase in the number of recreational vehicles since 1950?

____

____

9. Now look at the two bar graphs, "Noise Sources." What do they show?

____

10. What is the total noise level (in decibels) for the motorcycle? ______

11. What is its noisiest part? ____________________

12. What is the total noise level (in decibels) of the snowmobile? ______

13. What is its noisiest part? ____________________

14. Use the noise level chart and find where each of these recreational vehicles would be on that scale. Is it above the danger level?

____

15. What do you think should be done about these two vehicles that contribute to noise pollution?

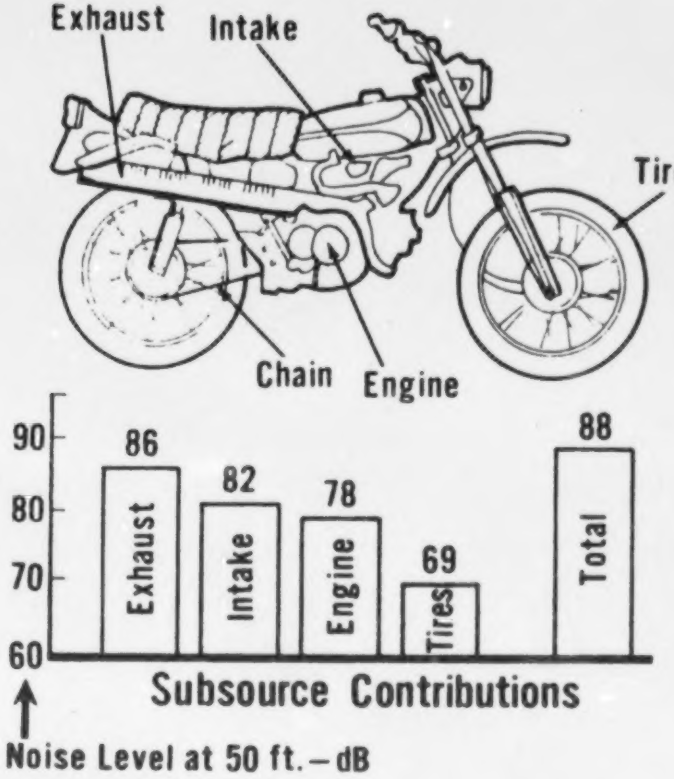
____

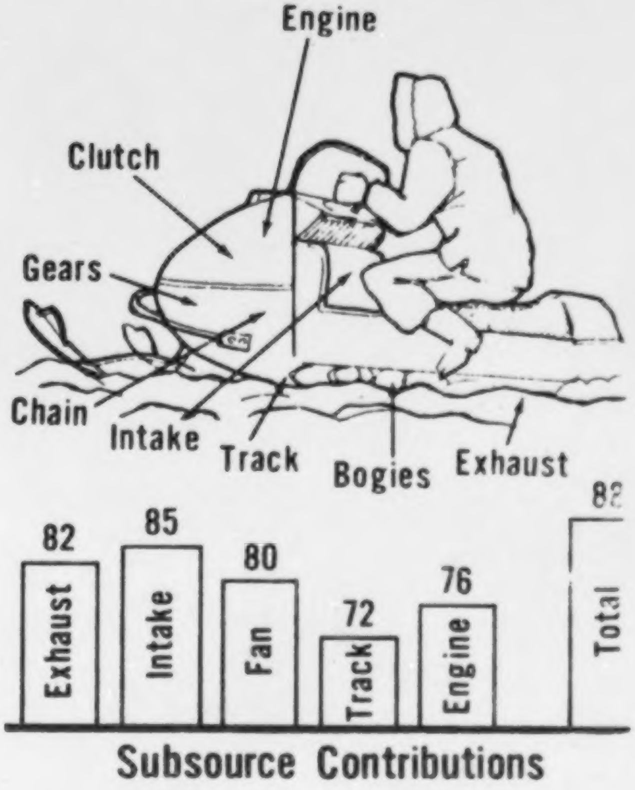
____

Why? __________________________

To accompany Activity 12

NOISE SOURCES:





To accompany Activity 12 Appendix A-16

NOISE LEVELS OF HOME APPLIANCES AND BUILDING EQUIPMENT

Noise Source	Level of Operator Exposure*	Level of Exposure** of People in Other Rooms
Refrigerator	40	32
Freezer	41	33
Humidifier	50	43
Floor Fan	51	1
Dehumidifier	52	45
Window Fan	54	47
Clothes Dryer	55	48
Air Conditioner	55	48
Clothes Washer	60	52
Stove Hood Exhaust Fan	61	53
Electric Toothbrush	62	42
Dishwasher	64	56
Electric Can Opener	64	56
Food Mixer	65	57
Hair Dryer	66	51
Vacuum Cleaner	67	60
Electric Knife	68	60
Electric Knife Sharpener	70	62
Sewing Machine	70	62
Food Blender	73	65
Electric Shaver	75	52
Electric Lawn Mower	75	55
Food Disposal (Grinder)	76	68
Electric Edger and Trimmer	81	61
Hedge Clippers	84	64
Home Shop Tools	85	75

*Termed "primary exposure"

**Termed "secondary exposure"

OPERATORS OR PASSENGERS EXPOSED TO HAZARDOUS NOISE

Source	Noise Level in dBA		Approximate Numbe of People Exposed (In Millions)
	Average	Maximum	
Snowmobiles	108	112	1.60
Chain Saws	100	110	2.50
Motorcycles	95	110	3.00
Motorboats (over 45 HP)	95	105	8.80
Light Utility Helicopters	94	100	0.05
General Aviation Aircraft	90	103	0.03
Commercial Propeller Aircraft	88	100	5.00
Internal Combustion Lawnmowers and other Noisy Lawn Care Equipment	87	95	23.00
Trucks (Personal Use)	85	100	5.00
Home Shop Tools	85	98	13.00
Highway Buses	82	90	2.00
Subways	80	93	2.15

OUR WORLD'S WATER

Research these questions:

1. What is the earth's water system?

2. Why is water so important to plants and animals alike?

3. How does water get into the air from bodies of water?

4. Name two ways it is returned to the bodies of water from the air.

5. What are ocean currents?

   How do they affect land?

6. How would you explain oil appearing on San Diego beaches several days after a leak in an off-shore oil well near Santa Barbara?

7. React to this statement: "Water pollution is a worldwide problem."

   What makes you feel that way?

8. Write a poem (rhyming, unrhymed, Haiku, or cinquain) about water. Let it reflect how you feel about the earth's water system.

____

____

____

OR

____

____

____

____

____

OR

____

____

____

____

FORMAT FOR HAIKU AND CINQUAIN

The form for a Haiku poem is three lines totaling 17 syllables. The first line has five syllables. The second line has seven syllables. The third line has five syllables.

Example: Spring Fish

Little golden fish
Swims upstream always moving
In clear, quick water.

The form for another kind of verse, called "cinquain" (also called "diamond form"), is five lines. The first line is a topic noun--it will tell what you are writing about. The next line consists of two adjectives describing the noun. The next line has three verbs that are related to the noun. The next line is a phrase about the noun. The last line is a synonym for the topic noun.

Example: Spring Fish

Fish
Slippery, shiny
Moving, eating, mating.
Keeping a balance
with nature,
Salmon.

ENERGY SOURCES

RESEARCH GUIDE

1. What is your topic? ______________________________

2. Use the Energy Source Fact Sheets and encyclopedias to find information on this topic.

3. Use the information to answer these questions?

    Where is it found? ______________________________

    How is it taken from the ground? ______________________________

    How is it transported? ______________________________

    How is it used today? ______________________________

    How will it be used in the future? ______________________________

    What are its advantages? ______________________________

    What are its problems? ______________________________

4. Think of how you are going to present this material to the class. If charts, diagrams, or pictures will help, draw them on large paper so they can be seen.

5. Present your report to the class so they will know as much as possible about the source you researched.

PRESENT ENERGY SOURCES

Oil and natural gas account for 78% of the energy used in the United States. We are using up this limited natural resource fast. The United States uses more energy than any country in the world.

Use the two maps showing energy resources and the map, "Fuels That Utilities Burn," to help you answer some of these questions.

1. In the year 2000 it is possible that our supply of oil and natural gas will be used up. How many years away is the year 2000?

   ______________ How old will you be? ________

2. What are some things that would have to change if we had no more oil or natural gas?

   ____

   ____

   ____

3. On the map, "Fuels That Utilities Burn," label the directions NORTH, SOUTH, EAST and WEST. (Use a wall map or an atlas if you need help.) When you are sure you have the directions labeled correctly, put a check (✓) in this space: ____

4. Utility companies burn fuel to make electricity. This map shows the fossil fuel use of the utility companies in each state. Which states burn only gas?

   ____

5. Which state uses only oil? ______________________

6. Name three states that use only coal. ______________________

   ____

7. Which states use only gas and oil?

   ____

8. Which states use only coal and oil?

   ____

9. Which fossil fuel is used most? ______________________

10. Which fossil fuel does California use most? ______________

11. What part of the country uses mostly coal? ____________________

12. What part of the country uses no coal? ________________________

13. Now look at the sheet that has two small maps on it. Using the "Utilities" map and the small "Coal Fields" map, what can you say about why coal probably is not used on the west coast?

____

14. Use the maps to explain why Texas, Oklahoma, and Louisiana utilities burn the fuel they do.

____

15. Why do you think North Dakota uses coal instead of oil or natural gas?

____

16. Locate Minnesota on the "Utilities" map. What fuels are used there?

____

How much oil and natural gas does Minnesota have as a natural resource?

____

How do you think Minnesota utilities get the fuel they burn?

____

How would this affect the cost of electricity in Minnesota?

____

17. What do you think would happen to a state like Nevada that has no coal and very little oil and gas if other states would not sell them these energy sources?

____

____

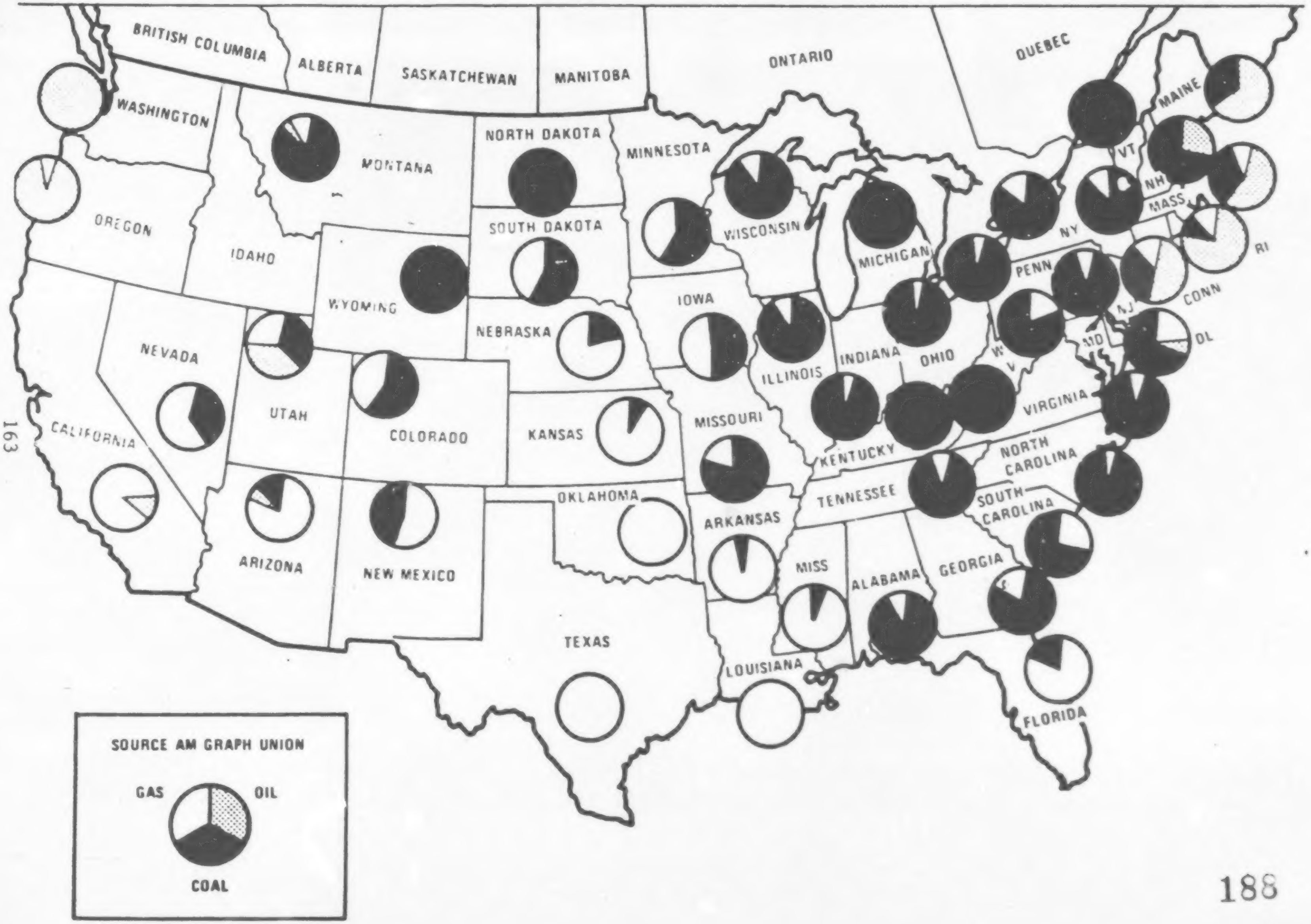
18. If you were in control of all the oil and gas resources in California, would you sell these resources to Nevada? ________
Why? ____

____

19. If all the oil and gas in California was used up, what would you do?

20. Write a letter to the governor of California suggesting what you think should be done. (Think of the proper form for writing a letter to the governor. Be sure to state reasons for your suggestions.)

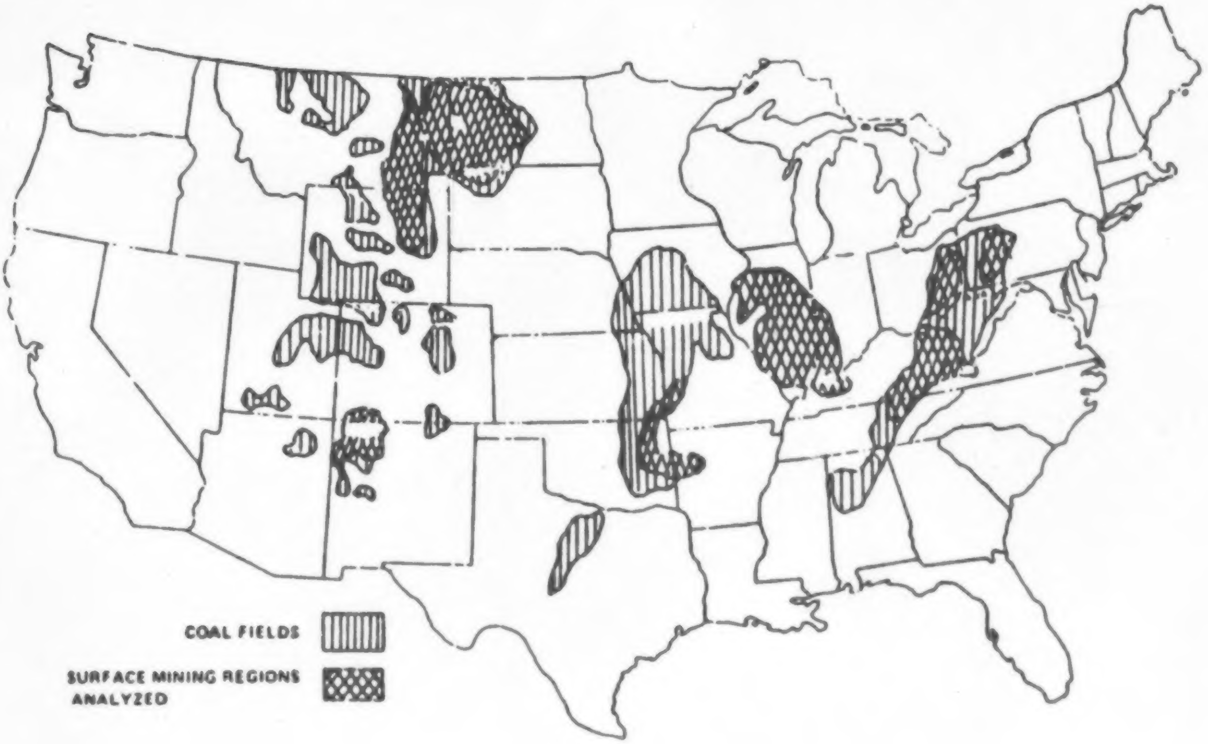
FUELS THAT UTILITIES BURN


BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
WASHINGTON
OREGON
CALIFORNIA
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
ILLINOIS
MICHIGAN
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISS
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
VIRGINIA
W V
PENN
NY
MD
NJ
DL
CONN
RI
MASS
VT
NH
MAINE
SOURCE AM GRAPH UNION
GAS
OIL
COAL

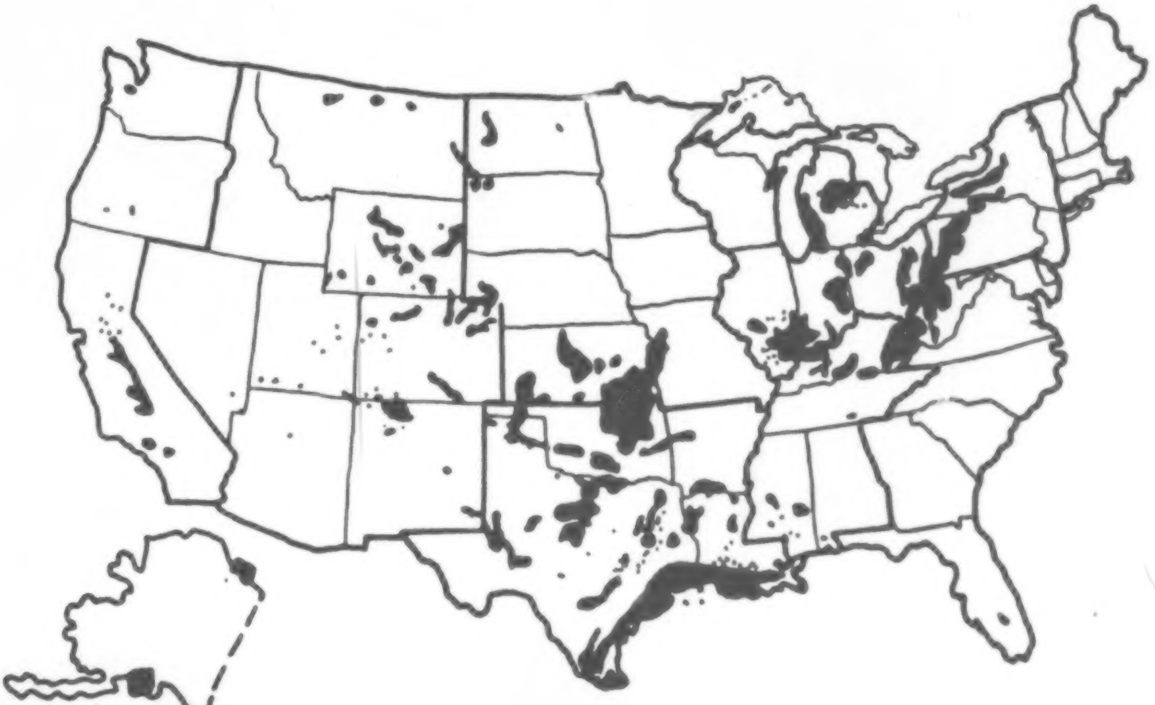
To accompany Activity 18

Appendix A-22

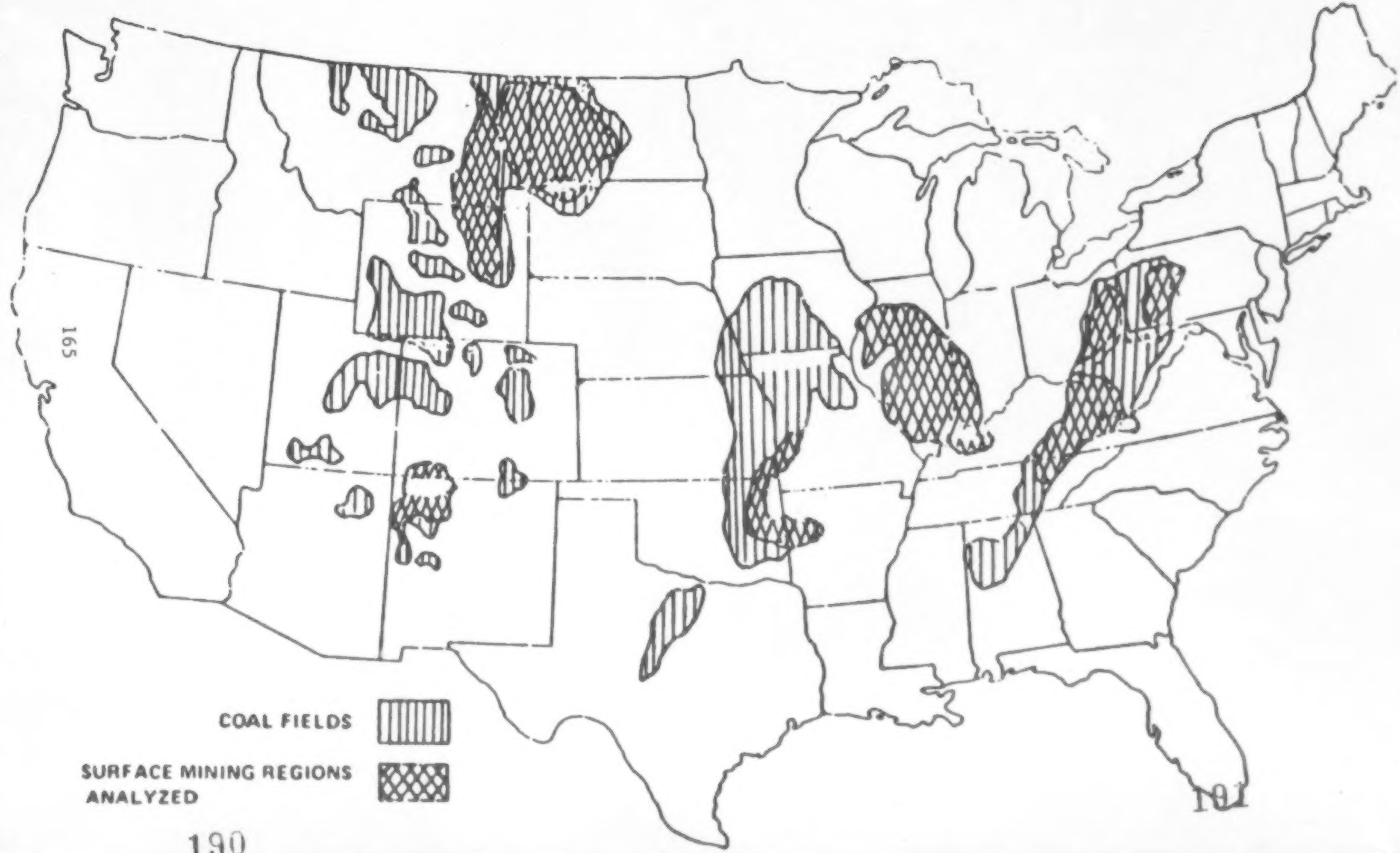
COAL FIELDS IN THE UNITED STATES


COAL FIELDS ▥
SURFACE MINING REGIONS ANALYZED ▦

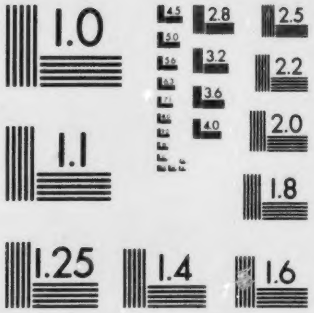
OIL AND GAS FIELDS IN THE UNITED STATES



COAL FIELDS IN THE UNITED STATES


165
COAL FIELDS ▥
SURFACE MINING REGIONS ANALYZED ▩

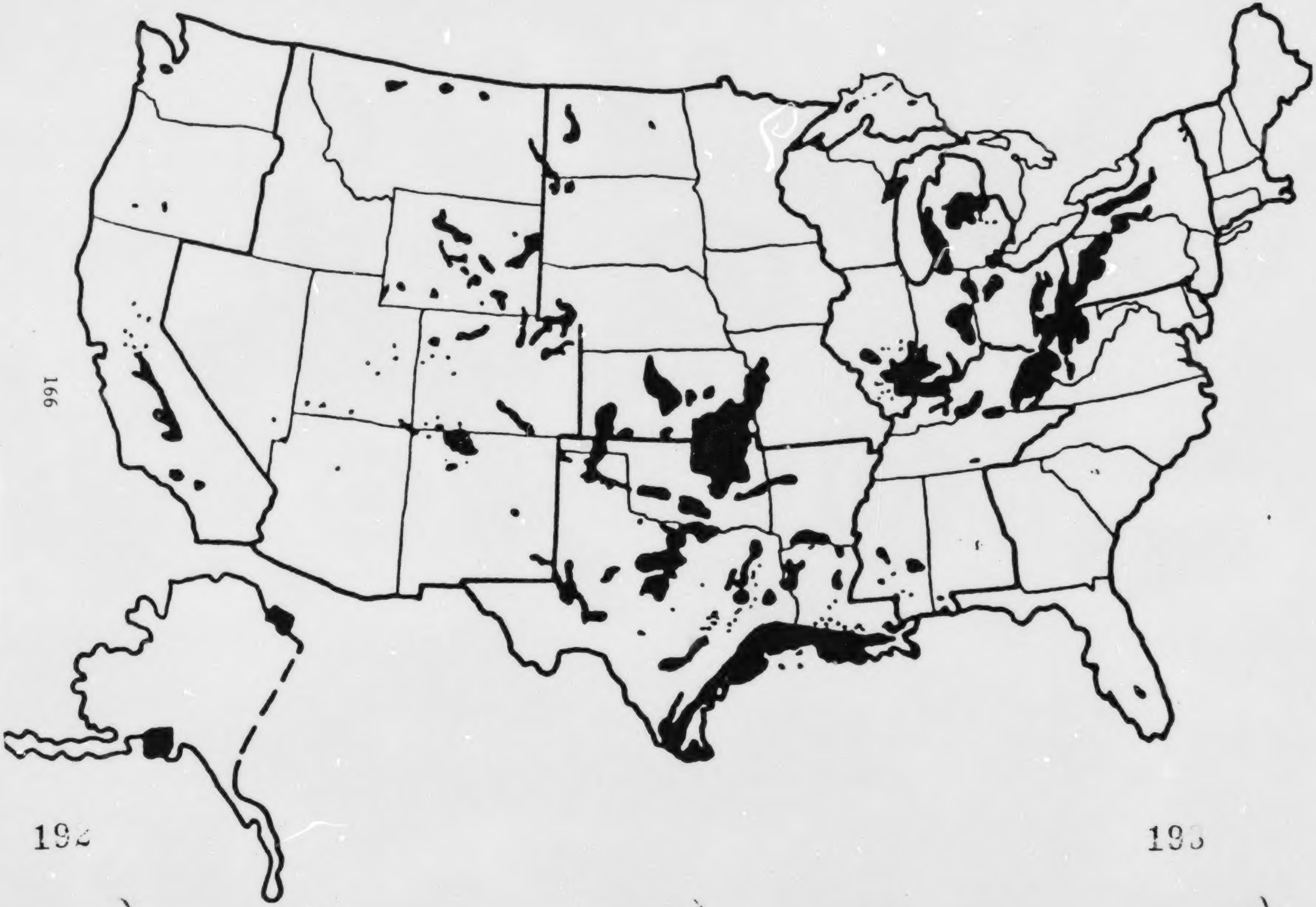
P6


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

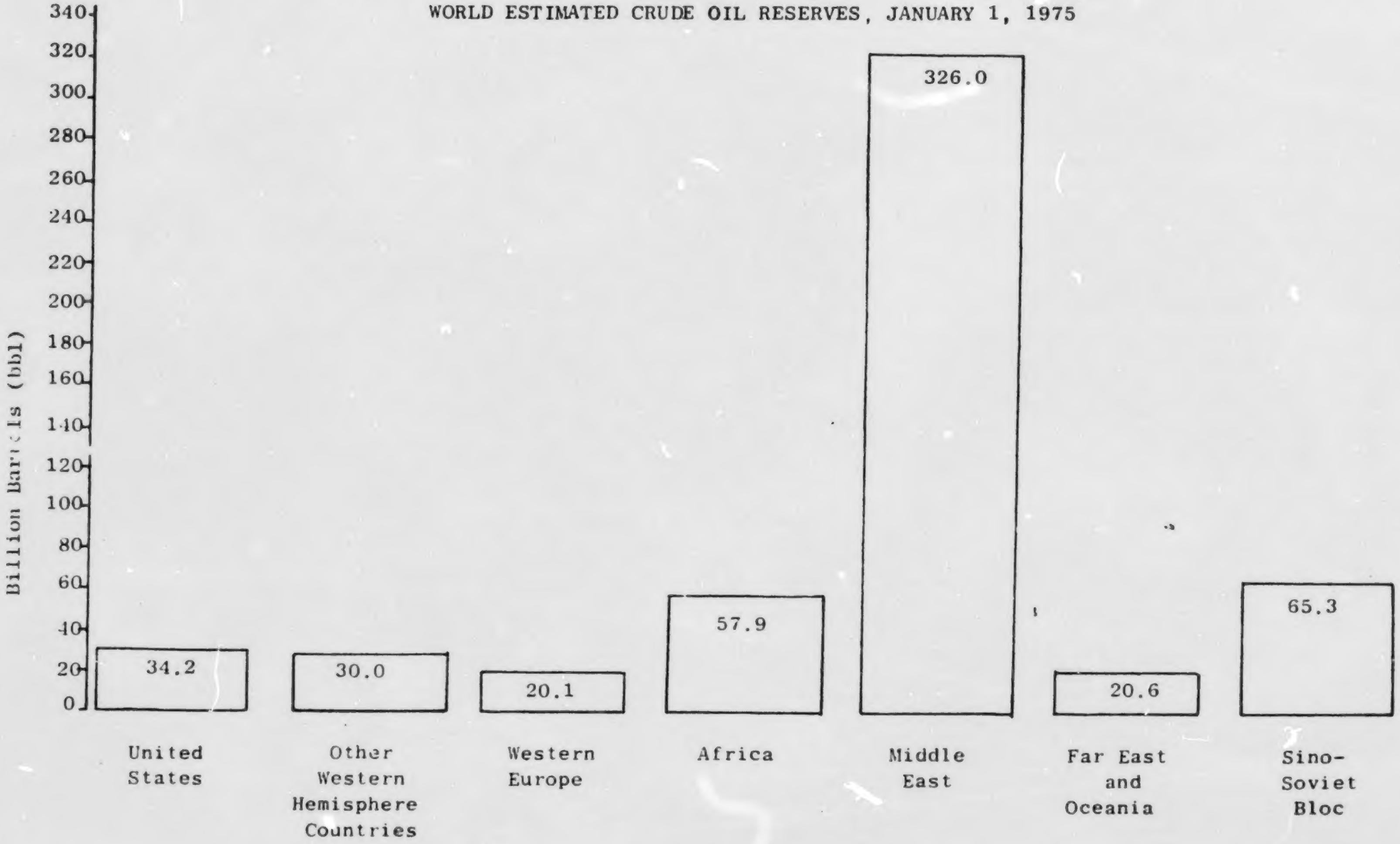
OIL AND GAS FIELDS IN THE UNITED STATES

To accompany Activity 18



Appendix A-25

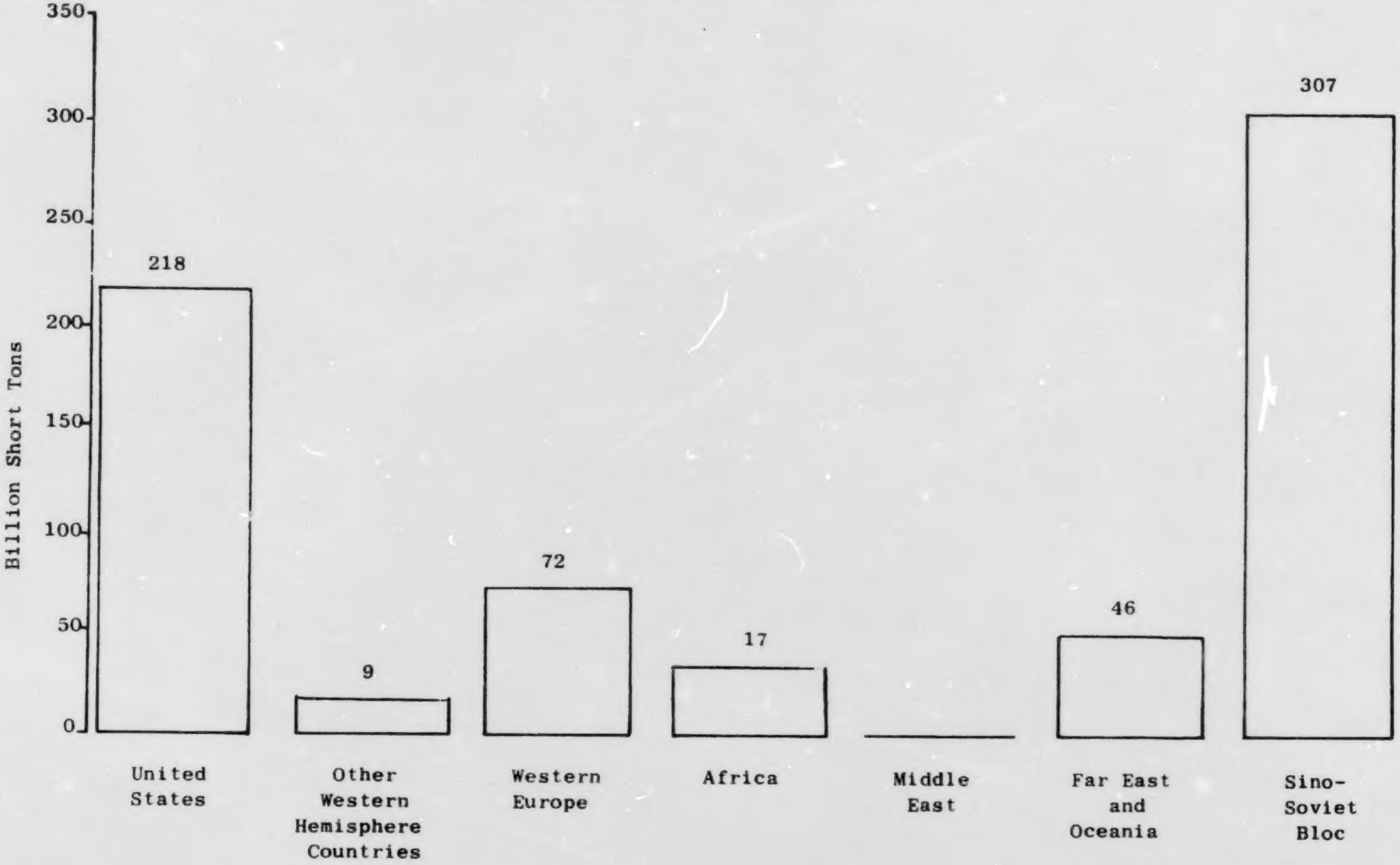
WORLD ESTIMATED CRUDE OIL RESERVES, JANUARY 1, 1975



Source: Energy Perspectives 2, U.S. Department of Interior, June, 1976

To accompany Activity 19

WORLD RECOVERABLE COAL RESERVES, 1974

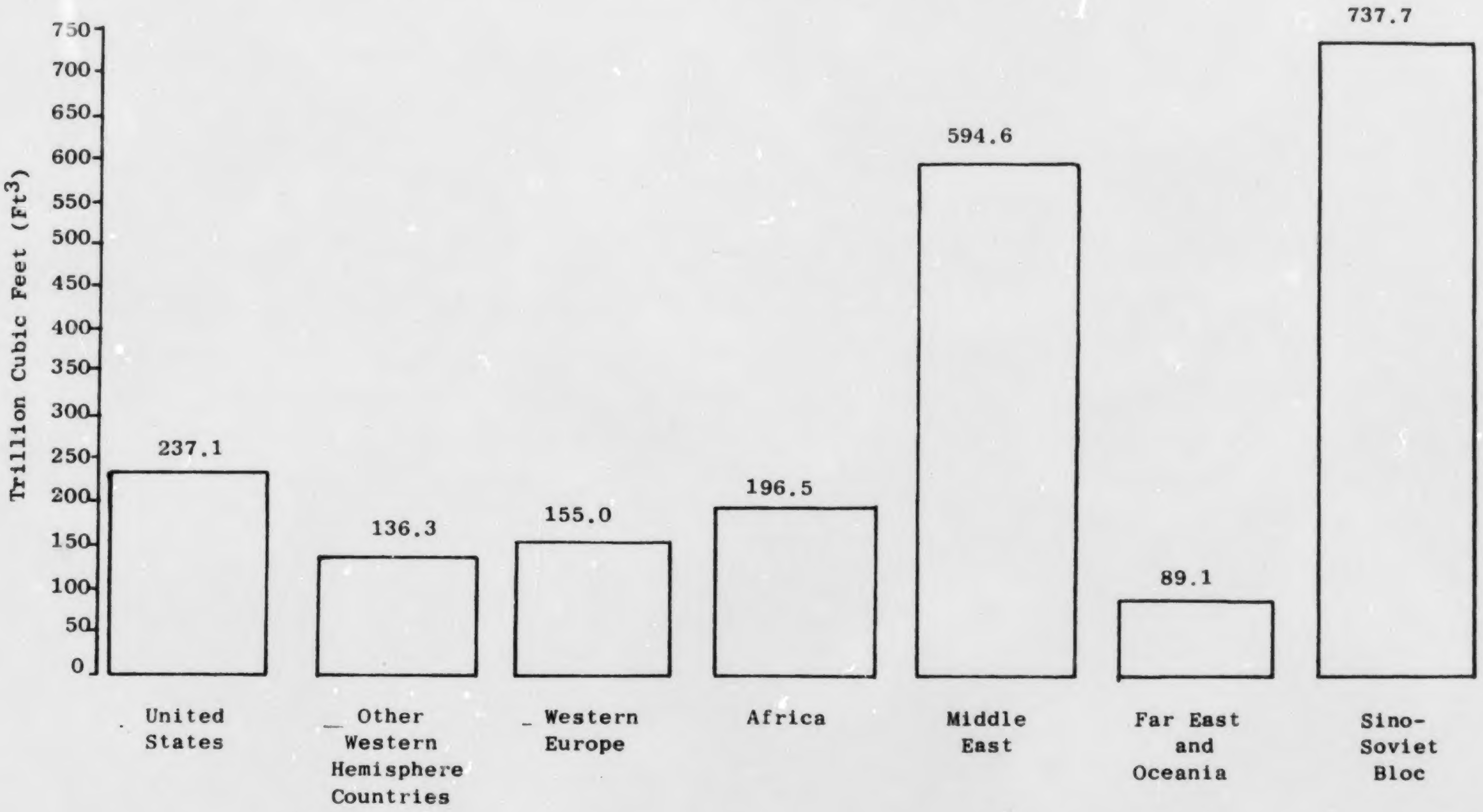


Source: Energy Perspectives 2, U.S. Department of Interior, June, 1976

Appendix A-27

To accompany Activity 19

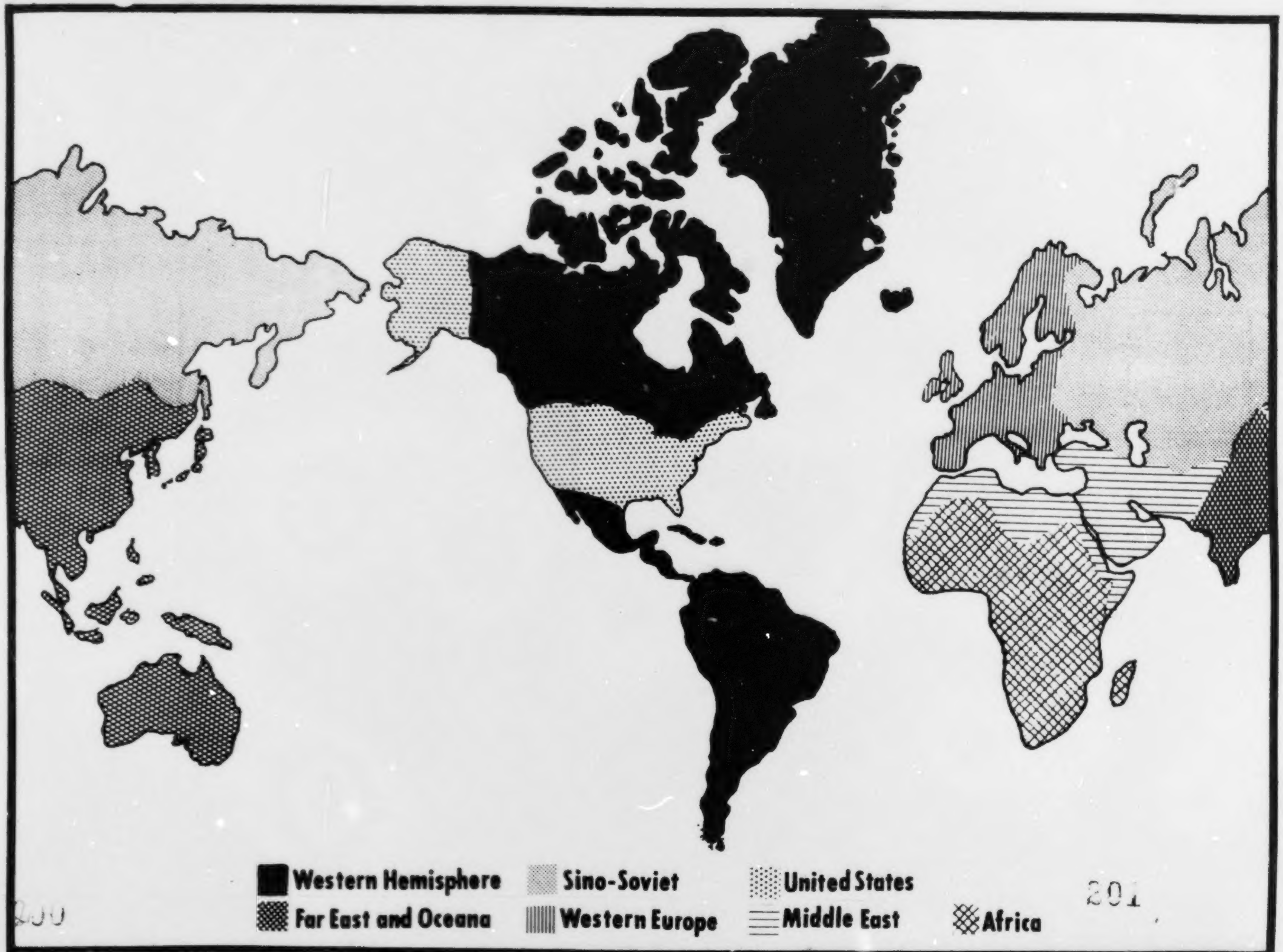
WORLD ESTIMATED NATURAL GAS RESERVES, JANUARY 1, 1975



Source: Energy Perspective 2, U.S. Department of Interior, June, 1976

Appendix A-28

To accompany Activity 19


Western Hemisphere
Sino-Soviet
United States
Far East and Oceana
Western Europe
Middle East
Africa

WORLD SOURCES OF ENERGY

Look at the three graphs:

1. Estimated Crude Oil Reserves
2. Estimated Natural Gas Reserves
3. Recoverable Coal Reserves

After looking at the three graphs, answer the following questions. (You will also need your copy of a world map to help you with this activity sheet.)

1. How many different countries, continents, or areas of the world are listed on each of the three graphs?

   Answer: ______________

2. Are the names of the countries or areas the same on each graph?

   Answer: ______________

3. List the names of the countries or areas found on the graphs.

   Answer: ____

   ____

   ____

   ____

   ____

   ____

   ____

4. Use the Crude Oil Reserves graph to answer the following questions:

   a. Which country or area has the greatest amount of crude oil in reserve?

      Name: ______________________________

      What is the number amount in billions of barrels of oil listed for this country or area?

      Amount: ______________________________

b. Which country or area has the least amount of crude oil in reserve?

Name: ______________________________

What is the number amount in billions of barrels of oil listed for this country or area?

Amount: ______________________________

c. What is the number amount in billions of barrels of oil listed for the United States?

Amount: ______________________________

d. Compare the United States with the other six areas of the world by listing those areas with more and those areas with less crude oil in reserve than the U.S.

AREAS WITH MORE CRUDE OIL	AREAS WITH LESS CRUDE OIL

e. What is the total amount of crude oil in reserve for the whole world? (Hint: If you know what the total is for each of the seven areas, what must you do to get the entire sum for the world?)

Amount: ______________________________

f. Add up the total oil reserves for all areas of the world except the Middle East. Total for the six areas:

____

g. Do the six areas of the world (which include the United States) have more or less total crude oil in reserve than the Middle East?

Answer: ____________________

h. State any ideas or conclusions that you now have on crude oil reserves in the world. Use any data given on the chart to support your conclusions.

i. If you were in the business of selling oil well drilling equipment, what area or areas of the world would you go to first?

Answer: ______________________________

5. Look now at the graph entitled "World Recoverable Coal Reserves, 1974."

a. List in order, from the largest number to the smallest number, the names of the countries or areas, and record the number amount next to the name.

COUNTRY OR AREA NAME	NUMBER AMOUNT LISTED FOR EACH COUNTRY

b. Oil is recorded in billion barrels (bbl). Find and write down the way coal is weighed and recorded on your coal reserves map.

Answer: ________________________

c. Look in a dictionary under "Weights and Measures" (usually listed in the back of the dictionary), and find out what a short ton is and write the weight down.

Answer: ________________________

d. The United States has 218 billion short tons (218,000,000,000) of coal in recoverable reserves. How many pounds are there in 218,000,000,000 short tons? (Hint: If you know what the weight of one short ton is, what would you do to find the product sum of 218,000,000,000 short tons?)

Answer: ____________________________

e. Look back at your answer to 5a and add up the world's total recoverable coal reserves (in billion short tons) and record your answer.

Answer: ____________________________

f. From the graph on world coal reserves we can see that the United States has a lot of coal--but, what is a lot? To find out specifically, we can compare the United States total to the world total in fraction form. The numerator of the fraction is the United States total and the denominator is the world total. Find these two numbers and record your answer in fraction form.

Answer: ______________________

Now drop off the last two numbers of the numerator and denominator and write down your new fraction.

Answer: __________

Can you simplify (reduce) the fractional number that you just wrote? If you can, what is your answer?

Answer: ______

You now know the approximate fraction of the total world coal that the United States has in reserve.

g. What information have you learned or what conclusions can you make from your learnings on world coal reserves? (Use any data on the chart to support your answers and conclusion.)

Answer: ______________________________________

____

____

____

____

____

6. Look at your third map on natural gas resources in the world. Tell what unit of measure is used to record natural gas. (Remember that coal is recorded in short tons and oil is recorded in barrels.)

Answer: ______________________

a. List the number amount (in TRILLION CUBIC FEET) for the United States, and tell how the United States ranks in relation to the other countries or areas of the world.

Answer: ______________________

____

____

b. Suppose the United States needed to buy natural gas. If the Sino-Soviet Bloc countries would not sell natural gas to the United States, where would be the next best location for purchasing natural gas? List the country or area and its number amount.

Name: ______________________

Amount: ______________________

c. What means of transportation do you think would probably be used to get natural gas from the Middle East to the United States? Trace your route on a world map and write down the names of the land areas and bodies of water over which you would travel.

Answer: ______________________

____

____

d. If we have to pay $100 a mile for transporting natural gas from the Middle East to the United States, how much would transportation costs add to the cost of the natural gas that was purchased? (Hint: Trace your route on the map with yarn and find out in the legend the scale of inches to miles. When you find out how many miles your route covers, then multiply by $100 per mile.)

Answer: ______________________

e. What have you learned about the cost of natural gas to our country when it has to be imported?

____

____

7. We have covered many ideas on the topics of oil, coal, and natural gas. From what you have learned, and by using the three graphs, summarize what you know (in your own words) about these three energy resources.

____

____

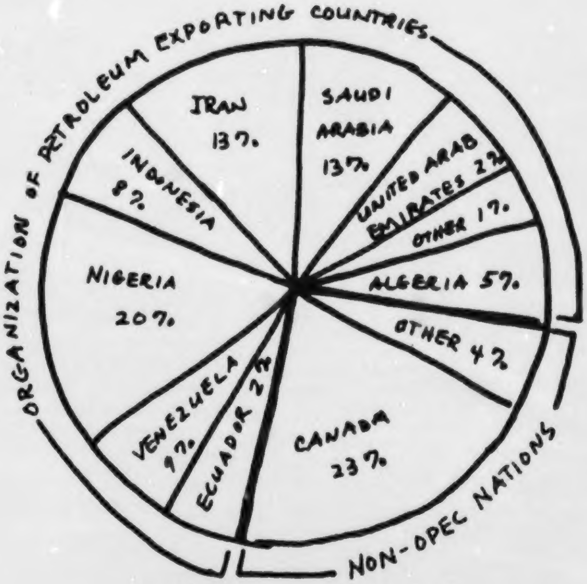
____

____

____

THE OIL WE IMPORT

Because America's demand for oil is greater than its supply, we must buy oil from other countries to help meet the demand. This is called *importing*. From 1969 to 1974 our imports of oil doubled, and the cost per barrel increased more than four times.



PERCENT OF TOTAL U.S. CRUDE IMPORTS IN 1974

1. Find each country shown in the graph on a world map. Then, below, list each country in its proper region. Beside each country's name write the percentage of oil the U.S. imports from it.

North America

_______________ _____

Latin America

_______________ _____

_______________ _____

The Mideast

_______________ _____

_______________ _____

_______________ _____

Southeast Asia

_______________ _____

_______________ _____

Africa

_______________ _____

_______________ _____

2. The OPEC nations have formed an association to regulate the price they charge for their crude oil. What do the letters OPEC stand for?

____

3. What are the OPEC nations? _______________________________

____

4. What percentage of imported U.S. oil comes from OPEC nations? _____

5. The country that sells the U.S. the most crude oil says it will need to end all shipments to the U.S. by 1982. Which country is this?

____

6. Why does the U.S. need to import oil? ________________________

____

7. From what you have just done, what would you say about the oil shortage in the United States?

____

____

8. React to these solutions to our oil shortage. State whether you agree or disagree and *give reasons* for your answers.

We should increase domestic production of fossil fuels.

____

____

We should decrease our demand for oil.

____

____

We should develop new energy alternatives.

____

____

We should increase oil imports to meet our growing demand for it.

____

____

We should stop importing. We should become energy-independent.

____

____

To accompany Activity 22 Appendix A-32

"CHECK YOUR LIFE-STYLE" INVENTORY

1. What does life-style mean?

2. List at least 10 things that make up your life-style:

3. Put a star (*) beside the ones that require energy from a non-renewable resource.

4. Put a circle (o) beside the ones that come from a natural resource.

5. Put a check (✓) beside the ones that would cause some kind of pollution.

6. What is one thing you could change that would save energy?

   How would that affect your life-style?

7. What is one thing you could change that would conserve a natural resource?

   How would that change your life-style?

8. Make a statement about how your life-style is affecting our environment.

To accompany Activity 23

FUTURE ENERGY RESOURCES

SOURCE	HOW IS IT PRODUCED?	IS IT EXPENSIVE?	INEXPENSIVE?	WHAT ARE ITS PROBLEMS?
Nuclear				
Shale Oil				
Solar				
Geothermal				

SOURCE	HOW IS IT PRODUCED?	IS IT		WHAT ARE ITS PROBLEMS?
		EXPENSIVE?	INEXPENSIVE?	
Wind and Water				

Give each resource a rank (from 1 to 5) in terms of the following questions?

A. Which energy source will last the longest?
B. Which will cost the least to develop?
C. Which will cost the least to use?
D. Which is found everywhere on earth?
E. Which will cause the least pollution?

ENERGY SOURCE	A	B	C	D	E	TOTAL
Nuclear energy						
Shale oil						
Solar energy						
Geothermal energy						
Wind and water power						

Which energy resource do you recommend we use for the future? ____________

Why? ____

TWO POSSIBLE FUTURE SOURCES OF ENERGY

Two future energy sources may be geothermal energy (energy from deep inside the earth) and solar energy (energy coming directly from the sun). Scientists and engineers are working on how to use these two sources. There are other possible sources for future use, but this activity will look at only geothermal and solar.

1. Look at the map, "Geothermal Resources in the United States." In what part of the country are most geothermal resources found?

   ____

2. In what part of the country are there very few geothermal resources?

   ____

   How do you think this would affect Texas using geothermal as an energy source?

   ____

   ____

3. List four states that have no geothermal resources.

   ____________________________ ______________________________

   ____________________________ ______________________________

4. List four states that have a large amount of geothermal resources.

   ____________________________ ______________________________

   ____________________________ ______________________________

   How do you think this would affect California using geothermal as an energy source?

   ____

   ____

5. Write a summary of what the map on geothermal resources shows.

   ____

   ____

   ____

   ____

6. In your opinion, what is the possibility of using geothermal energy as a source for the future?

Give reasons for your answer.

7. Now look at the "Potential Solar Energy by Region." What is the highest amount of potential solar energy?

____________ In what state is it? ____________________

8. What is the smallest amount of potential solar energy?

____________ In what state is it? ____________________

How would you explain these two facts?

9. List the four highest amounts of potential solar energy and give the state.

AMOUNT	STATE
____	____________________
____	____________________
____	____________________
____	____________________

How do you think this would affect these states using solar energy?

10. Write a summary of what the map on potential solar energy shows.

11. In your opinion, what is the possibility of using solar energy as a source for the future?

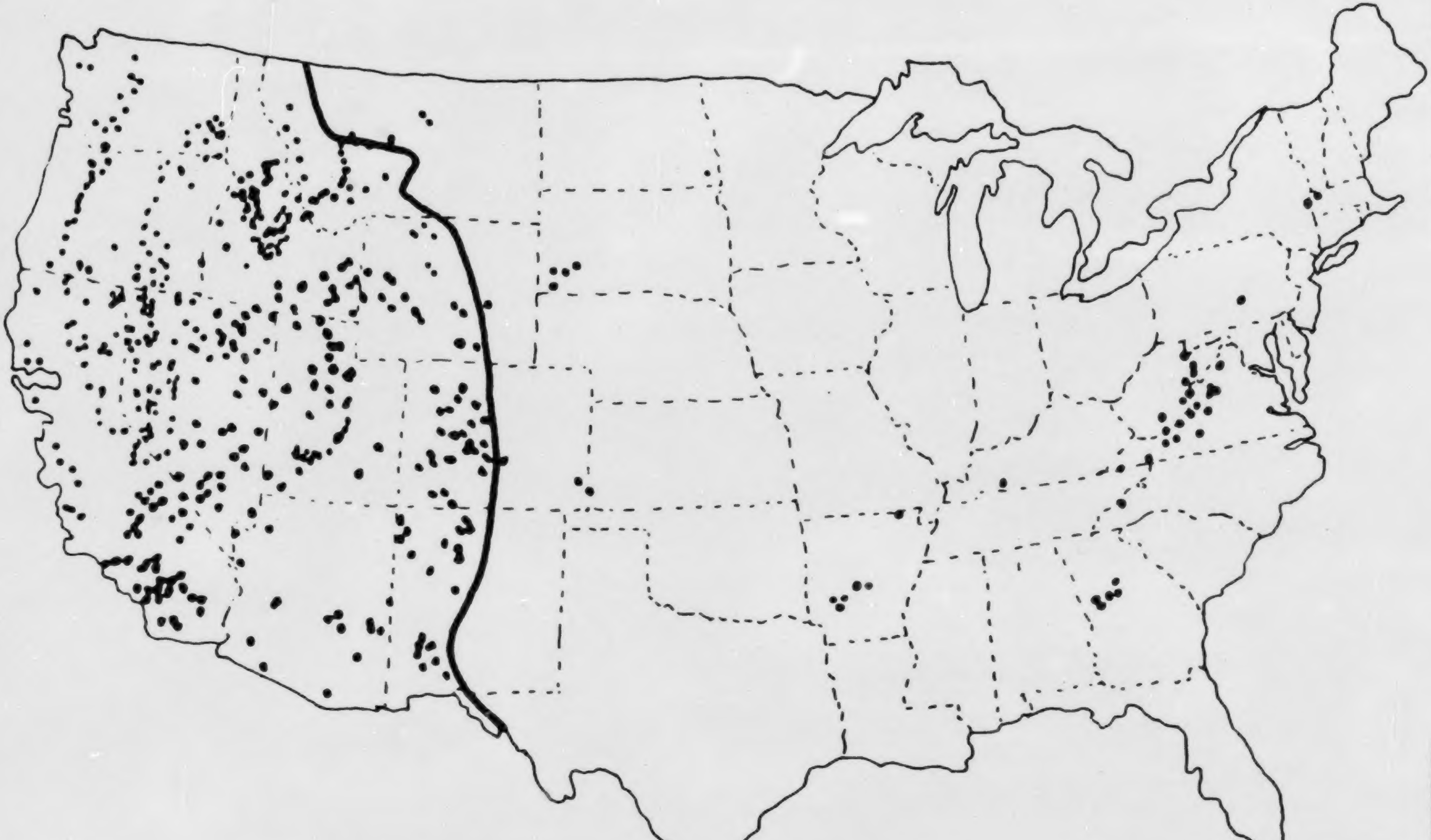
Give reasons for your answer.

12. What recommendations would you make for the future use of these two sources (solar and geothermal) in the United States?

13. What recommendations would you make for the future use of these two sources in California?

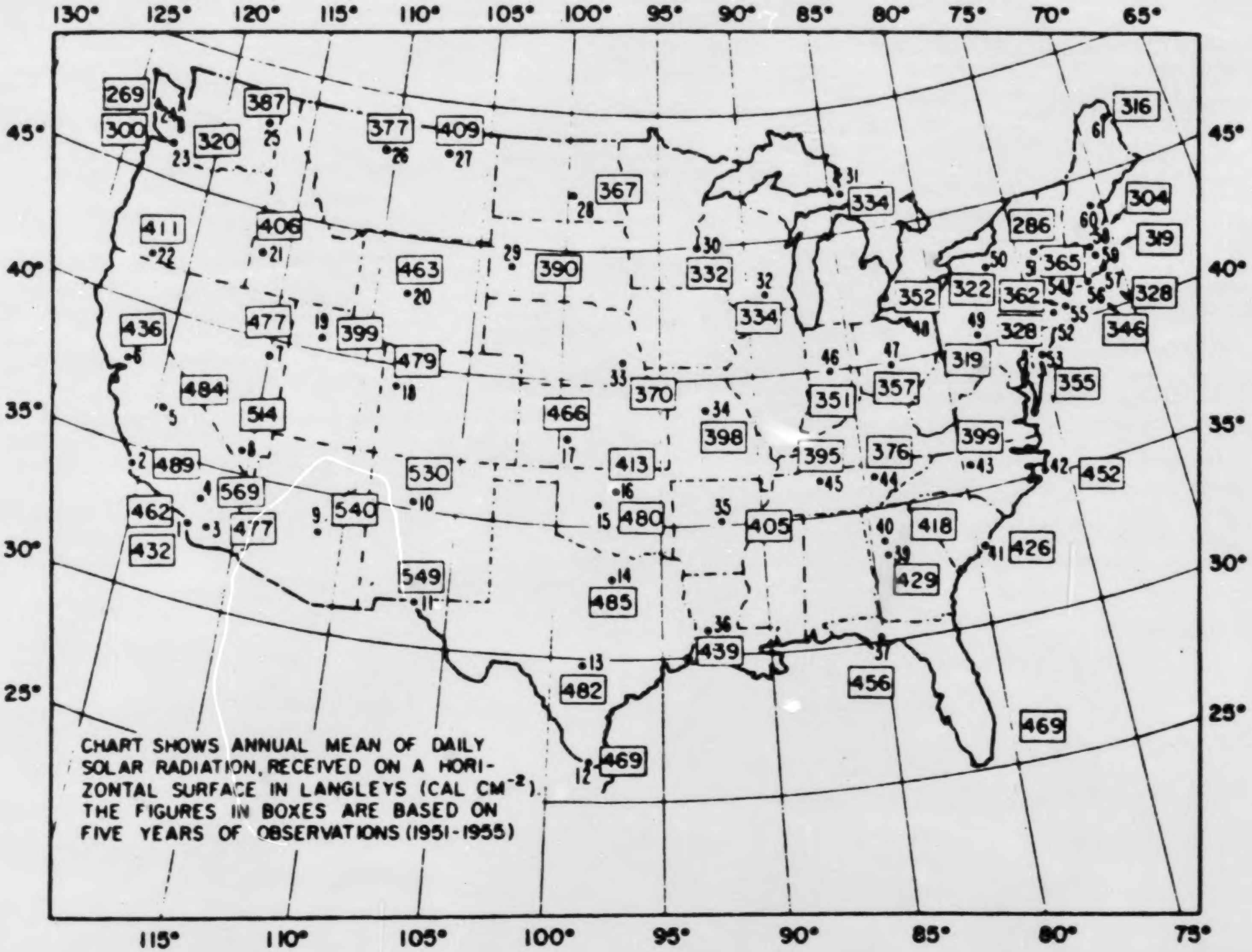
GEOTHERMAL RESOURCES IN THE UNITED STATES

To accompany Activity 24



Appendix A-35

POTENTIAL SOLAR ENERGY BY REGION


130° 125° 120° 115° 110° 105° 100° 95° 90° 85° 80° 75° 70° 65°
45° 40° 35° 30° 25°
115° 110° 105° 100° 95° 90° 85° 80° 75°
269
300
387
320
377
409
316
367
334
304
411
406
286
319
463
390
332
365
352
322
362
328
436
477
399
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328
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479
319
484
514
466
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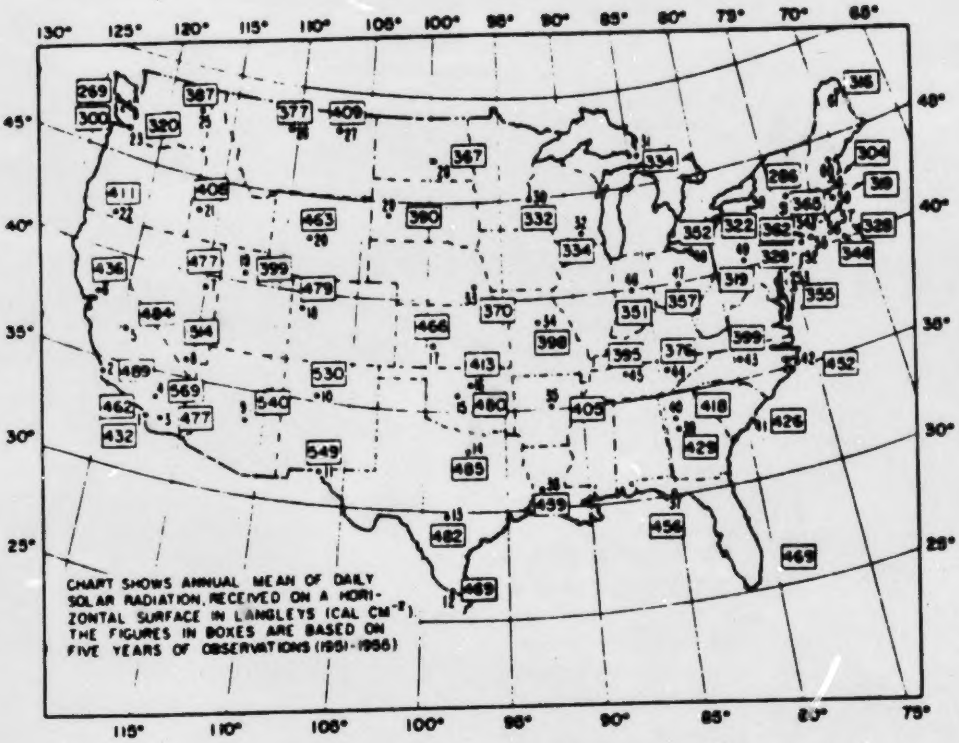
351
357
355
398
399
489
530
413
395
376
452
569
462
540
480
405
418
426
477
432
549
485
429
439
456
482
469
469

CHART SHOWS ANNUAL MEAN OF DAILY SOLAR RADIATION, RECEIVED ON A HORIZONTAL SURFACE IN LANGLEYS (CAL CM^{-2}). THE FIGURES IN BOXES ARE BASED ON FIVE YEARS OF OBSERVATIONS (1951-1955)

FIG. 2 ANNUAL MEAN OF DAILY INSOLATION RECEIVED ON A HORIZONTAL SURFACE AT 61 LOCATIONS IN CONTINENTAL UNITED STATES

POTENTIAL SOLAR ENERGY BY REGION


130°
125°
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115°
110°
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80°
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70°
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45°
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35°
30°
25°
269
300
320
387
377
409
367
411
408
463
380
332
334
334
436
477
399
479
484
514
466
370
398
489
569
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477
432
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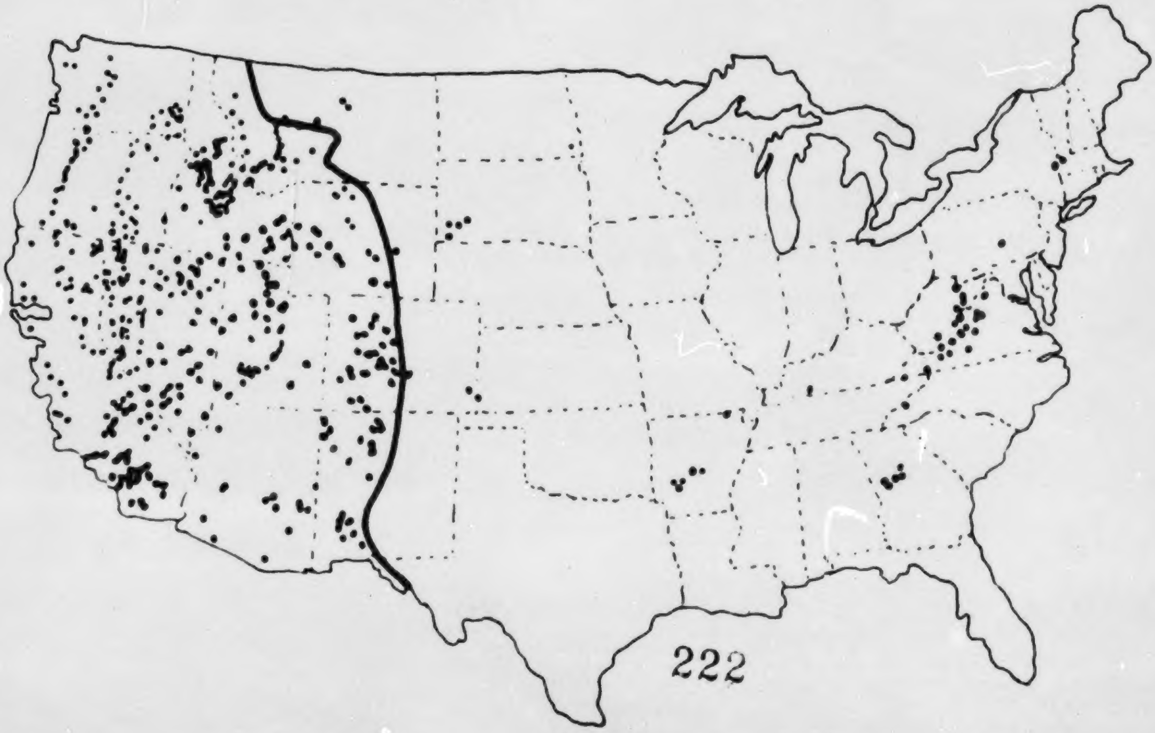
395
376
452
418
426
429
459
456
469
115°
110°
105°
100°
95°
90°
85°
80°
75°

CHART SHOWS ANNUAL MEAN OF DAILY SOLAR RADIATION, RECEIVED ON A HORIZONTAL SURFACE IN LANGLEYS (CAL CM^{-2}). THE FIGURES IN BOXES ARE BASED ON FIVE YEARS OF OBSERVATIONS (1951-1956)

FIG. 2 ANNUAL MEAN OF DAILY INSOLATION RECEIVED ON A HORIZONTAL SURFACE AT 61 LOCATIONS IN CONTINENTAL UNITED STATES

GEOTHERMAL RESOURCES IN THE UNITED STATES



222

FROM MINE TO ELECTRIC LIGHT

I. Coal is mined either by surface or underground mining. Before it leaves the mine, it is cleaned, crushed, and sorted.

About two-thirds of our coal is transported by rail, much of it in special cars. One coal train can carry as much as 15,000 tons per trip.

Forty-six percent of U.S. generators are powered by coal. Power plants burn coal to turn water into steam. The steam turns a turbine (a series of wheels with vanes like a windmill). The turbine rotates coils of wire in a generator through a magnetic field to produce electricity.

Electricity is transported on wires at very high voltages. Electricity is usually not shipped more than 600 miles by wire because of expense and loss of energy. Only 26 percent of the original energy remains when the electricity is used.

Electricity lights the lamps in your home. How many other uses of electricity can you name?

II. ____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

____________ ____________ ____________

Put a star beside the ones you think you could do without.

III. Decide whether the following fact is a problem (P) or an opportunity (O). Put a P or an O or both in the blanks.

_____ 1. 90 percent of the U.S. fossil fuel reserves (coal, oil, natural gas) is coal.

_____ 2. Some deep mines are dangerous.

_____ 3. 50 percent of our mineable coal is in the western states.

_____ 4. We have enough coal to last for 350 years at current level of use.

_____ 5. Mining coal can cause damage to the environment.

_____ 6. In the future, we will rely more on coal as a source of synthetic oil and gas.

COAL RESERVES

Using the coal reserves map and a map of the United States, answer the following questions. (You will need to know that the larger the number, the greater the amount of coal in the state.)

1. How many numbered states are listed on the coal reserves map?

 ____

2. Which state has the largest amount of the original deposit remaining?

 State name: ____________________

 Number amount of deposit: __________

3. What numbered state is east of the state with the largest amount?

 State name: ____________________

 Number amount of deposit: __________

4. What is the name of the state furthest west on the map that has a large amount of its original deposit?

 State name: ____________________

 What is the number amount listed for this state?

 Number amount: __________

5. What two states have the same number amount of coal reserves?

 State names: ____

 What is the number amount listed for those two states?

 Number amount: __________

6. What is the name of the state with the smallest (least) amount of its coal that is not yet used? (It must be a numbered state.)

 State name: ____________________

 What is the number amount listed for this state?

 Number amount: __________

7. What numbered state is south of the state with the smallest (least) amount?

 State name: ____________________

 Number amount: __________

8. Find New Mexico on the map and list the number amount for this state.

Number amount: __________

9. What is the name of the border state (touching state) north of New Mexico?

State name: ____________________

What is the number amount listed for this state?

Number amount: __________

10. What border state (touching state) is west of New Mexico?

State name: ____________________

What is the number amount listed for this state?

Number amount: __________

11. What border state (touching state) is north of Arizona?

State name: ____________________

What is the number amount listed for this state?

Number amount: __________

12. You have now found the names of 11 states and the number amount of coal reserves. Find the names of the remaining numbered states and list them below:

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

State name: ____________________ Number amount: _____

13. What state do we live in? ____________________

Does our state have any coal reserves? ____________________

14. What is the state closest to California that has a large coal reserve that could be used as a source of energy?

____

15. Now that you have finished this activity, share anything you have learned about coal reserves--an important source of energy in the United States. Use the space below to write out your answer.

____

____

____

____

16. Name one advantage of using coal.

____

17. Name one disadvantage of using coal.

____

18. Make a statement about how you see coal as a future energy source.

____

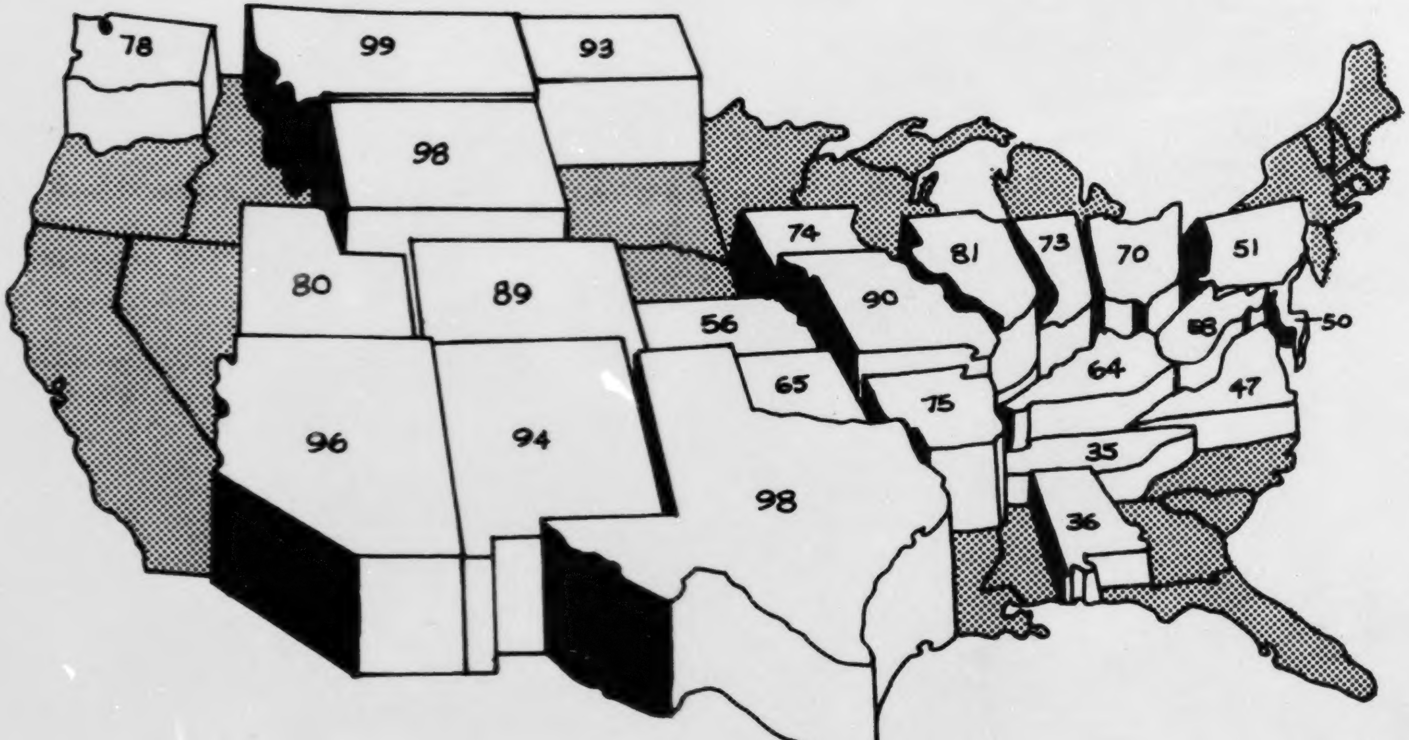
____

____

____

To accompany Activity 26

U.S.COAL RESERVES
1977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36

Appendix A-40

DECISIONS! DECISIONS! WHO MAKES DECISIONS?

Students your age make many decisions every day. How many decisions do you make? To discover your decision-making rating, answer each question below YES or NO.

1. Do you decide who you will play with after school? NO ☐ YES ☐
2. Do you decide what clothes to wear? NO ☐ YES ☐
3. Do you decide whether or not to pay attention to your teacher in class? NO ☐ YES ☐
4. Do you decide what games you play? NO ☐ YES ☐
5. Do you decide what you will buy with your own money? NO ☐ YES ☐
6. Do you decide what TV programs you will watch? NO ☐ YES ☐
7. Do you decide what time you will go to bed on school nights? NO ☐ YES ☐
8. Do you decide what time school starts in the morning? NO ☐ YES ☐

Total NO Total Yes

Add up your decision-making score. ☐ ☐

ARE YOU A DECISION-MAKER?

SAME-O-SAME-O

A Fable

The town of Same-o-Same-o was secluded, far away from the rest of the world. In this town, everything was always the same. People drove the same car year after year after year. They wore the same clothes for years and did the same things in their leisure time. They never changed their life-style because the same way was always the right way. The townspeople always used the same amount of electricity, gas, and water. Same-o-Same-o had one gas line and one electric line coming from Big City 2,000 miles away. The town also had only one well which used an electric pump to supply the town's water.

Then one day J. P., the son of the mayor, came back to Same-o-Same-o after four years of college. He was the first citizen of Same-o-Same-o ever to go away to college. He had studied business and advertising.

The first thing J. P. did was set up a Business Consulting Agency for himself. He consulted first with the gas station businessmen. He convinced them that they should advertise so people would use their cars more. This would mean more gas sales for them.

The new car dealer was J. P.'s next visit. J. P. told the dealer that through advertising, he could convince people that they needed a big, new luxurious car. The plan would make lots of money for him.

The landscaping company of Same-o-Same-o was next. J. P. suggested that people should have more plants, bigger lawns, more outside lighting, and more outside gas barbecues. It was easy to convince people that more lights would be safer, more plants would be prettier, and outdoor entertaining would be more fun.

The manager of the hamburger stand was told he should update his packaging. Each item should be packaged separately so that the amount would look larger and the food would stay warmer. J. P. convinced them that this way could save by making the hamburgers smaller but the packaging bigger. Besides, he pointed out, packaging is only paper and plastic.

The general store owner was not left out of J. P.'s campaign. Trash compactors, electric mixers, curling irons, electric curlers, hair dryers, dishwashers, garbage disposals, washers, dryers, and electric toys were added to the store's inventory. The clothing store owner was encouraged to carry more clothes made of nylon so that they were wrinkle free. J. P. saw to it that swimming pools and Hot-Tub spas were promoted. Air conditioning was suggested for homes and businesses.

All over Same-o-Same-o, things began changing rapidly. People began buying big new cars and energy-gobbling appliances. Soon there were many swimming pools being installed. Giant green lawns were all around. Each business was air-conditioned and had a lighted sign that stayed on all night to advertise.

With Same-o-Same-o's one gas line and one electric line the town was now experiencing shortages. The city barely had enough electricity to pump water from its one well. The mayor called the townspeople together to discuss what should be done.

"We must cut down our use of energy," he said. "Maybe we shouldn't water our lawns or fill our swimming pools." "Boo," said the people with large lawns and new swimming pools. "Maybe we should cut down on the lighting for businesses and stop selling new cars," said the mayor. "Boo," said the businessmen.

The people of Same-o-Same-o didn't want to cut down because they were accustomed to their new way of life. The businesses didn't want to cut down because they were making so much money. Alas, such problems! Why are the people so unhappy, with so many problems, when before everyone was always happy about being the same?

SOURCES OF ENERGY MATERIALS

American Gas Association
1515 Wilson Blvd.
Arlington, VA 22209

American Nuclear Society
San Diego Chapter
P.O. Box 81451
San Diego, CA

American Nuclear Society
National Office
244 East Ogden Ave.
Hinsdale, IL 60521

American Petroleum Institute
1801 "K" Street NW
Washington, DC 20006

American Public Power Association
2600 Virginia Ave. NW
Washington, DC 20037

Atomic Industrial Forum
475 Park Ave. South
New York, NY 10016

Citizens' Advisory Committee on
Environmental Quality
1700 Pennsylvania Ave. NW
Washington, DC 20006

Ecology Forum
124 East 39th Street
New York, NY 10016

Edison Electric Institute
90 Park Ave.
New York, NY 10016

Thomas Alva Edison Foundation
Cambridge Office Plaza, Suite 143
18280 West Ten Mile Rd.
Southfield, MI 48075

Electrical Industries Association
6055 E. Washington Blvd.
Los Angeles, CA 90040

Energy Conservation Research
9 Birch Road
Malvern, PA 19355

Energy Information Center
100 California St.
San Francisco, CA 94111

Energy Research and Development Adm.
Department of Energy
Office of Public Affairs
Washington, DC

Environmental Action Foundation
724 Dupont Circle Building
Washington, DC 20036

EXXON, USA
Public Affairs Department
P.O. Box 2180
Houston, TX 77001

Federal Energy Administration
Department of Energy
111 Pine St.
San Francisco, CA 94111

Foundation for Alternative Energy
407 N. Maple Drive
Beverly Hills, CA 90210

Interstate Oil Compact Commission
Educational Department
P.O. Box 53127
Oklahoma City, OK 73105

National Audubon Society
1412 - 16th Street NW
Washington, DC 20036

National Coal Association
1130 - 17th St. NW
Washington, DC 20036

National Interviews
153 "E" Street SE
Washington, DC 20003

National Solar Heating and Cooling Information Center
P.O. Box 1607
Rockville, MD 20850

San Diego Ecology Centre
340 Kalmia St.
San Diego, CA 92101

San Diego Gas and Electric
P.O. Box 1831
San Diego, CA 92112

Scientists' Institute for Public Information
30 East 68th Street
New York, NY 10021

Shell Oil Company
Public Affairs
P.O. Box 2463
Houston, TX 77001

Sierra Club
1051 Mills Tower
San Francisco, CA 94104

Sierra Club, San Diego Chapter
1549 El Prado
San Diego, CA 92101

Solar Energy Research Institute
Department of Energy
Golden, CO

State Energy Resources Conservation
  and Development Commission
1111 Howe Ave.
Sacramento, CA 95825

U.S. Department of Interior
18th and "C" Street NW
Washington, DC 20240

U.S. Environmental Protection Agency
401 "M" Street SW
Washington, DC 20240

Appendix B

FACT SHEETS*

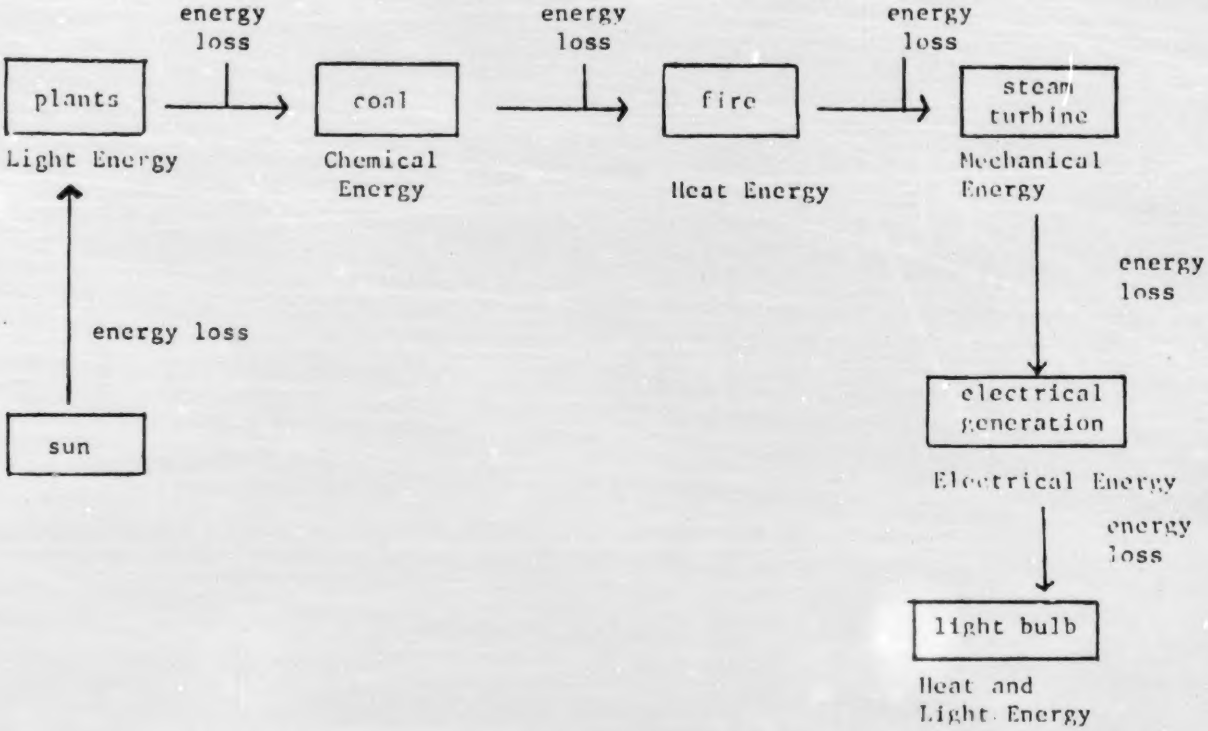
Introduction

What is Energy?

Energy equals the capacity to do work, and power is the rate at which work is done. The work it does allows the biosphere to operate and allows us to maintain our agricultural and industrial civilization. Radiant energy flowing from the sun warms the earth to temperatures which sustain life, drives the hydrological cycle of evaporation and precipitation, powers the winds and ocean currents, and is captured by the green plant which is the food base for most living things. The plant was also the starting point of fossil fuels.

Two ideas about energy are important in understanding energy problems:

1. Energy is not really consumed, but only changed in form. For example, energy could flow through the system diagrammed below:


energy loss
energy loss
energy loss
plants
coal
fire
steam turbine
Light Energy
Chemical Energy
Heat Energy
Mechanical Energy
energy loss
energy loss
sun
electrical generation
Electrical Energy
energy loss
light bulb
Heat and Light Energy

---

*Taken from *Energy for Today and Tomorrow*, a San Diego City/County Schools Publication.

2. When energy is converted from one form to another as shown above, not all the energy is changed to the new form - some is lost or wasted.

The more conversions between the primary source of energy and the final use of energy, the greater the energy waste.

This wasted energy cannot be recycled. Since it can no longer be put to productive use, it is lost.

The primary energy sources are solar, hydro, coal, wind, petroleum and natural gas, nuclear and geothermal.

Energy in San Diego

According to R. R. Higgins, Economist with San Diego Gas and Electric Company, ".... There are no commercially developed natural fuel resources in the county of the types which could be used by San Diego Gas and Electric Company. Over the years there have been unsuccessful explorations for petroleum and petroleum by-products in various parts of the county both on-shore and off-shore. Due to the scarcity of natural water, there is no hydro-electric potential within the county and no prospects for such. SDG&E is currently exploring the potential for geothermal fluids as an energy source. However, the geothermal wells which we are attempting to develop are located in Imperial County. The potential energy in tidal wave action has been harnessed for electric generation in very few cases in other parts of the world where the particular topography lends itself to the economic use of this energy as it does not in San Diego County. SDG&E is currently researching various methods of harnessing solar energy. However, we do not consider this form of energy to be a practical, large scale energy source in the immediate future. We are aware of a few windmill installations within our service area which provide at least part of the users' energy requirements. Here again, we do not feel wind power is a practical source of energy in the county.

SDG&E is cooperating with a petroleum company which plans to build an oil refinery in the Carlsbad area. The developing company, Pacific Resources In., also plans to produce synthetic gas as a by-product of the refinery operation. Some or all of this gas would be purchased by SDG&E for distribution to its customers in San Diego County. The crude oil source of the refinery products, however, would be from outside the continental United States.

In summary, San Diego County is blessed in many ways. However, it is not blessed with a practical source of energy of the type needed to supply electric and gas service."

The following fact sheets give you some basic information on the different energy sources.

ENERGY SOURCE FACT SHEET

COAL

Source

Underground, throughout the world (See World Book Encyclopedia Yearbook, 1974).

Collection

Underground and open pit mining

Transportation

Railroad, truck, barge, freighter

Storage

Stockpiles of mined coal

Use

Fuel to create heat for home and industry and to create electric power. A lot of coal is also used in making steel.

Consequences

Health hazards in mining coal; strip mining destroys surface environments; pollution from ashes, sulfur dioxide carbon dioxide, and carbon monoxide. New methods of mining coal, such as by gasification, are too expensive to use at the present time.

Availability

At the present rate of use, America's coal will last 650 years. The supply has not been used extensively in recent times due to the availability of petroleum products and the environmental concerns of mining and air pollution.

What is Coal?

Coal is a fossil fuel formed from dead plants and animals whose organic material is converted to coal by heat and pressure. It takes about 25 million years for coal to be formed.

Coal is burned to release its stored chemical energy. At present, coal provides about 20% of the United States' total energy use. Of the fossil fuels, America has more coal than oil or natural gas.

However, burning of coal can have harmful environmental effects. Coal often contains sulfur which creates a health hazard by becoming sulfur dioxide when the coal is burned. This burning also produces ashes and carbon dioxide. Some people fear that increased amounts of this gas in the air may change the weather. Present pollution control methods are very expensive. Furthermore, underground mining of coal is hazardous for miners. When the ground is stripped (like peeling an orange) to get the coal (strip mining), the earth is badly damaged. The environmental problems include what to do with the unsightly appearance, acids formed by water and leftover sulphur, ruined streams and groundwater sources, and hills of leftover dirt.

All of these environmental problems will have to be solved if coal is to be used as a major energy source. Coal is no longer used in California because of transportation and environmental considerations. However, several utility companies are currently studying its possible future use.

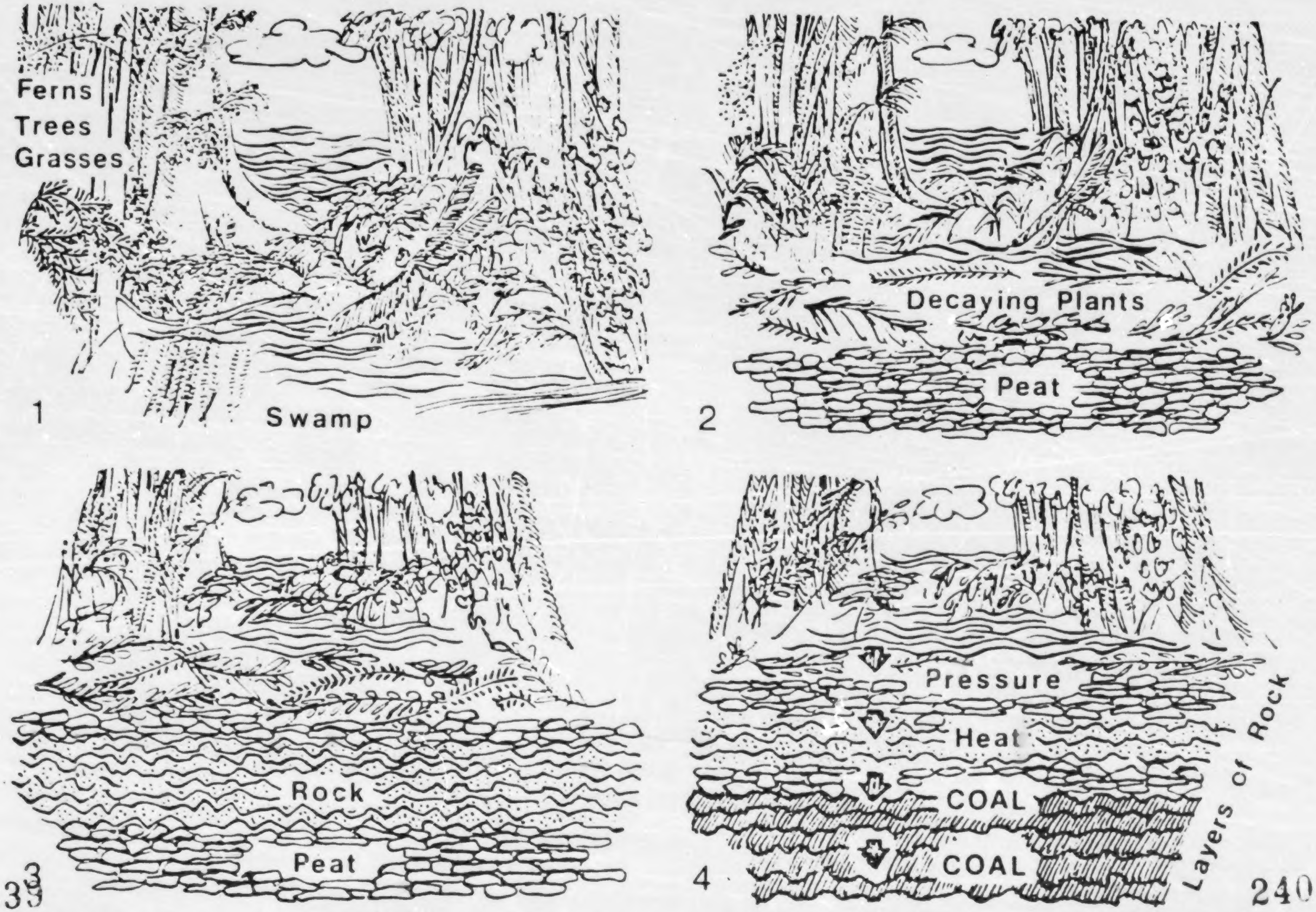
New Ideas

Some scientists think coal gasification will help solve the environmental problems. They want to set an underground coal seam on fire, then collect the gases which result. This method would get the energy value of coal without disturbing the surface environment or subjecting workers to underground mining hazards. Technology for this method needs improvement, however, and costs are high.

Cost

As of 1974, it would cost about$218 per year to heat a California home directly with coal it its use were permitted. This cost will go up as other fuels become scarce and the mining costs (labor, machinery, environmentsl, and health) increase.

HOW COAL WAS FORMED


Ferns
Trees
Grasses
1
Swamp
Decaying Plants
Peat
2
Rock
Peat
3
Pressure
Heat
COAL
COAL
Layers of Rock
4

ENERGY SOURCE FACT SHEET

CONSERVATION

Source

Available from all other sources of energy

Collection

None

Transportation

None

Storage

None

Use

Conservation will make exhaustible energy resources last longer and cost less.

Consequences

By conserving energy--that is, using less energy or using energy more efficiently--consumers or businesses save money. Conservation saves money for all of us because saved energy used somewhere else is cheaper than producing more new energy.

Availability

Conservation energy is available immediately, and the supply will last for as long as people are willing to make the effort.

What is Conservation Energy?

Conservation can be considered as an alternative source of energy. The technology now available, combined with strong conservation effort, would produce enough energy to maintain our present standard of living in the face of dwindling energy supplies.

Money must often be spent to conserve energy for other uses. An example is insulating and updating homes and buildings. However, this expense is less than the cost of producing the extra energy used by inefficient consumers. The more efficient use of energy also means an increase in the number of jobs created for each dollar of capital invested.

Conservation increases supply with the lowest risk. Many ways to conserve have been proven and the cost can be paid gradually in small steps. Once conservation improvements are made. there is no danger of this energy supply being cut off by foreign governments or changes in federal rules. Also, conservation is not likely to have a negative impact on the environment in the future.

Improved efficiency in energy use is the first step towards a basically different view of energy and the earth's physical resources. For this change each human being must recognize the limited nature of conventional energy resources. Moreover, each person must consider the serious environmental effects of the way we now obtain and use energy. In the long run, energy conservation efforts can show us how to balance our production and daily use of energy with the earth's ability to absorb wastes.

ENERGY SOURCE FACT SHEET

GEOTHERMAL ENERGY

Source

Earth heat in steam, hot water, and hot rock generally found where large amounts of molten rock lie near the surface ground. This heats deep underground bodies of water trapped in rock.

Collection

Steam or hot water rising to the surface

Transportation

Via pipes to (on site or adjacent) power plants

Storage

None after steam or hot water has been released

Use

Steam or hot water provides power to generate electricity

Consequences

Problems with disposal of waste water; high concentrations of minerals in water corrode turbines and pipes; foul smelling gases may be released into the air. Some experts worry that withdrawal of fluids may start underground earth movements. Onsite power conversion and return of water underground would eliminate some of these problems. If great amounts of heat are withdrawn from the interior of the earth, are there unknown thermal consequences?

Availability

Limited to those parts of the United States (mostly the western states) where geysers are found. The location of geothermal fields limits use of this energy source mostly to small cities in the western states.

What Is Geothermal Energy?

It is earth heat that might be able to provide much of the earth's energy. When underground heat meets underground water, hot water or steam is produced. Then steam may come up naturally as a geyser (Old Faithful) or a hot spring (Warner Hot Springs). See diagram on next page. There are several projected areas of development in California. At present, there are no geothermal wells being considered for power production in San Diego County. See diagram on next page.

By tapping 13% of the total heat from geothermal sources, we could generate enough electric power to equal 10 times our present energy output. Known geothermal sources are large and in general, easily developed. However, they are located mostly in the western states of the United States.

There are production as well as environmental problems associated with this energy source. Sometimes the water has a high level of minerals. This corrodes and clogs pipes and turbines if not removed and makes getting rid of waste waters difficult. The smelly gases, sulfur, ammonia, and boron released into the air cause pollution. There are worries that injection and withdrawals of water may trigger earth movements. The release of steam and hot water under pressure also causes noise (like a jet plane taking off) and odor. Many of these problems can be bypassed by using different methods of converting the available heat energy to electric power.

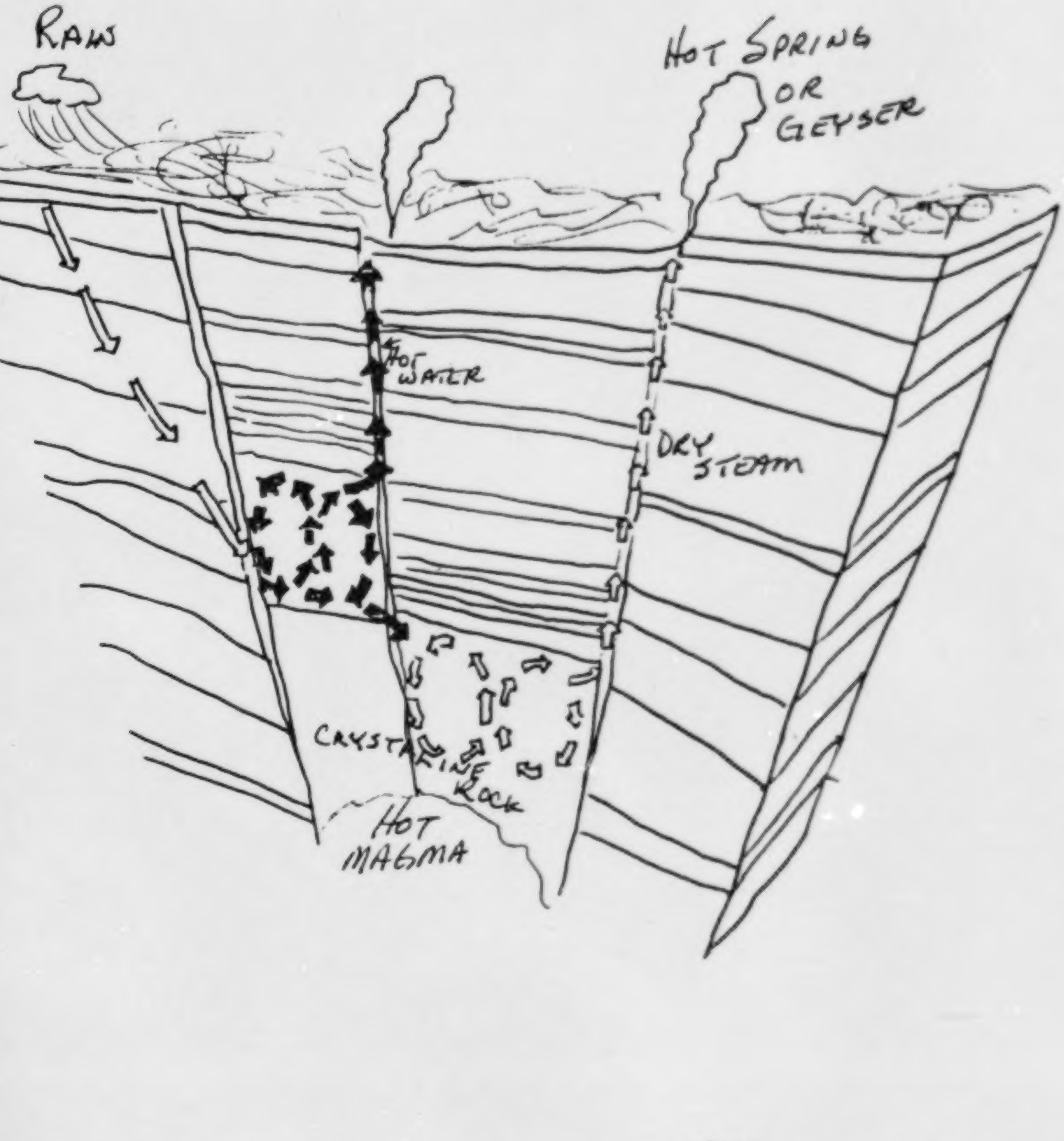
In addition, many of the good locations for geothermal power are in scenic areas such as Yellowstone National Park. Many people may not like changing those landscapes by adding electric powerplants. However, it does not affect the land the way mining does nor have the waste problems of fossil or nuclear fuels.

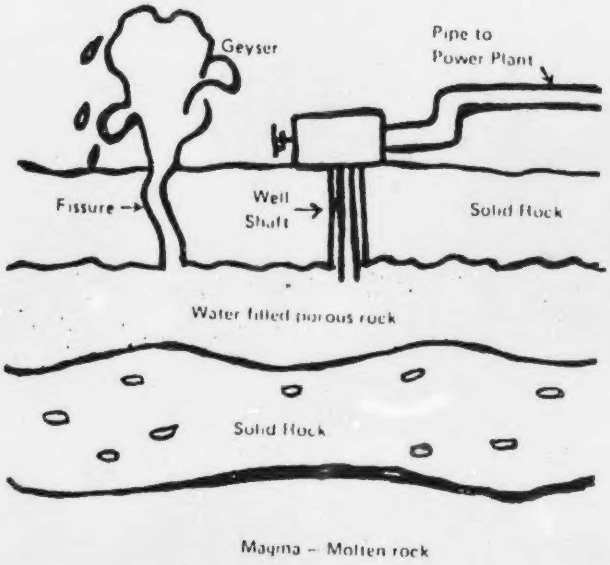
New Ideas

Some scientists are trying to find ways to circulate water through hot rocks which are not near underground water systems. If this happens, we could develop more geothermal sources.

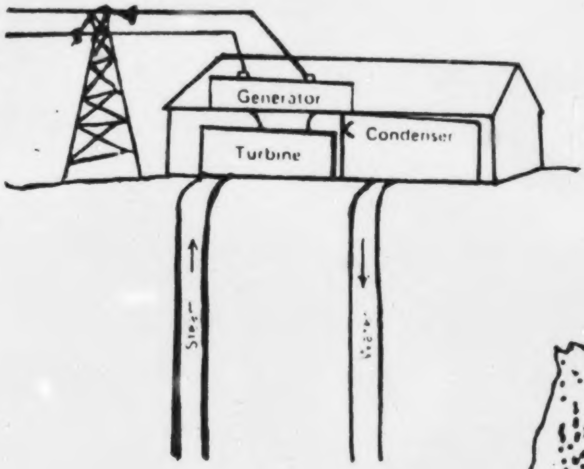
Cost

Costs are relatively low. Natural steam used to generate electricity is cheaper than oil, coal, or nuclear power. In areas of California where it is available, it would cost about $172 to heat a house (1974 rates).

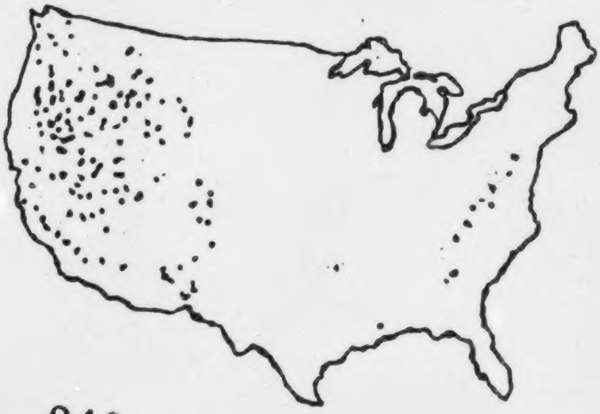

RAIN
HOT SPRING OR GEYSER
HOT WATER
DRY STEAM
CRYSTALLINE ROCK
HOT MAGMA


Geyser
Pipe to
Power Plant
Fissure
Well
Shaft
Solid Rock
Water filled porous rock
Solid Rock
Magma – Molten rock

Today, steam rising from the earth is used to turn a turbine to generate electricity. See diagram below.


Generator
Condenser
Turbine
Steam
Water

Map of Geothermal Regions



ENERGY SOURCE FACT SHEET

HYDROPOWER

Source

Streams, rivers, rain, snowmelt

Collection

Dams, natural waterfalls, lakes, streams, rivers

Transportation

Canals, flumes, chutes, aqueducts, pipelines, rivers

Storage

Reservoirs, pump storage

Use

To generate electric power

Consequences

Sediment filling up lake; loss of valuable farm land; destruction of animal habitats; high cost of constructing dams; limited life span of dams; hazards to life and property if it breaks.

Availability

For the sole purpose of creating electricity with no consideration to agriculture, river ecosystems and aesthetics, it would require damming all major rivers to produce one-half of the world's present power expenditure. Few new dam sites are available.

What is Hydroelectric?

Hydroelectric energy accounts for a small portion of electrical energy needs (about 4%). Hydroelectric energy is a clean source of power, but there are many environmental and social consequences. Damming buries large amounts of the best agricultural lands at a time when we cannot afford to lose them. In many cases, the lake behind a hydroelectric power dam starts filling with sediment and slowly renders it useless. In addition, it reduces the natural flow of sediment to the oceans, thus reducing the amount of sand for beaches.

Cost

The cost of hydroelectric power generation is also significant. Some experts estimate a life expectancy of as little as 10 years for a dam, due to sediment filling in the lake. Others estimate as much as 1,000 years of "life" for a typical dam. There is also an effect on wildlife because the sediment chokes out fish mating and spawning beds and destroys water vegetation. Probably the most important roadblock in the development of this source of energy is the lack of natural sites in the United States. Also, the high cost of building a dam limits the use of hydroelectric power in the future.

ENERGY SOURCE FACT SHEET

NATURAL GAS

Source

Underground gas wells or deposits; also made from coal or oil

Collection

Drilling for crude oil, drilling for natural gas deposits, collecting methane gas from organic wastes such as garbage

Transportation

Pipelines, gas tankers (trucks, railroad, ships)

Storage

Above ground in storage tanks as gas or liquid; underground wells

Use

Fuel to create heat for homes and industry; also used as a fuel to generate electricity

Consequences

As a fuel, natural gas is comparatively clean and inexpensive. (Prices are controlled by the government.) When natural gas is burned to make electric power, the nitrogen oxide given off, produced from the high temperature of burning, becomes part of smog.

Availability

In 1976, the known natural gas resources were expected to last only 10 to 15 years at that current rate of use. Estimates in 1978, based on new discoveries, suggest that supplies may be expected to last from 60 to 200 years at current world production rates. Check recent news reports for new developments in this rapidly changing situation.

What Is Natural Gas?

Natural gas is a fossil fuel mixture of gaseous hydrocarbons, mostly methane. Today, natural gas supplies one-third of the total energy used in the United States.

There is the possibility of importing liquefied natural gas from foreign sources. However, this would mean building expensive tankers and would increase the price of gas. Gasifying coal (changing coal into gas) could produce a lot of gas, but the cost of this is very high. Scientists are now trying to get usable methane gas from organic trash and garbage.

Environmental Problems

Gas is amost sulfur free and clean when burned. Gas has the least environmental impact of any fossil fuel. Natural gas used in large power plants, however, causes some environmental problems. In the high temperature produced for power generation, large quantities of nitrogen oxides (which help make smog) are produced. Also, carbon dioxide is given off into the air when any fossil fuel (oil, coal, or gas) is burned. Some scientists predict the worldwide increase in carbon dioxide may increase the earth's temperature. Fire, flameless booms, and vapor clouds are risks which may occur in handling liquefied natural gas.

Cost

Because the United States government has in the past controlled the price of gas, its cost is low. Many people say that low cost kept oil companies from trying to find new sources. In 1972, the cost of heating in a California home with natural gas was about $120. As government price controls are lifted, it is probable that gas prices will increase in the near future.

ENERGY SOURCE FACT SHEET

NUCLEAR FISSION

Source

Unanium 235, thorium, and plutonium in controlled nuclear reactions

Collection

Uranium and thorium are mined from the ground, then processed and enriched. Plutonium is produced as a byproduct in nuclear reactors.

Transportation

Fission fuels are carried in large casks made of lead and steel. These casks can survive through any foreseeable accident. They may be carried by rail or truck. The quantities of fuels needing transport are small due to the high energy content.

Storage

Fissionable materials may be stored for long periods of time in shielded locations.

Use

Nuclear fission makes heat which is used to boil water, making steam to run turbines which turn generators to make electricity. Other uses are desalting seawater, making hydrogen, coal gasification, and as a powerplant for ships and spacecraft.

Consequences

Much of the waste fuel must be kept away from living things for up to 250,000 years, (depending on the treatment of waste before storage, estimates of the time vary from six hundred years to several hundred thousand years). A nuclear reactor accident, such as the reactor core overheating, could cause the core to melt. It is considered possible that the water intended to cool the core might change to steam causing the protective shell to break and spread radioactive material over a wide area.

Availability

Sixty nuclear powerplants provide over 8% of our total electric power today. Estimates are about 35-40% of our electricity will come from nuclear fission plants in 1990. Uranium resources at these increasing rates of use will last about 30 years. If breeder reactors--they make (breed) another fuel (plutonium) as they use uranium and thorium--are built the supply may last 1500 years or more.

What is Nuclear Fission?

In fission, Uranium 235 atoms or other similar atoms are split into two or more fragments to release energy as heat.

There are two types of fission powerplants. One is called a Light Water Reactor. It uses water to heat other water to make steam to turn the generators. This requires a lot of cooling water. The second is a High Temperature Gas Reactor. This uses helium heated by the reactor which in turn heats the steam to turn the generators. One model uses helium itself to turn the generators. Of the two reactors, the High Temperature Gas Reactor is more efficient, producing more energy from a given amount of fuel.

Nuclear fission could be the way to provide lots of energy, save present energy sources (oil and natural gas), reduce fossil fuel air pollution, and produce other energy (hydrogen and coal gasification). This would help bridge the gap between the fossil fuel age and fusion power.

Even though nuclear energy may be an economical way to generate electricity, nuclear power reactors produce hazardous liquid and solid wastes. Much of this waste must be stored without any contact with the environment for up to 250,000 years.

Another danger is the possibility of a major accident such as a reactor core overheating. This could result in a hazardous leakage of radiation into the environment. Some experts say the chance of this is really quite small, perhaps as little as one in a billion.

Finally, there is the problem of security in the transport and storage of radioactive material.

Most of the problems mentioned above might (and likely will), be solved with good management and better technology, and probably will be solved. The question is whether it is worth the risk today and for future generations.

Cost

The cost of nuclear electric power is about the same as the cost of power from fossil fuels. Heating a home in California would cost about $510 per year.

SOURCES IN SAN DIEGO COUNTY

In San Diego County, the San Onofre nuclear generating station south of San Clemente is a functioning nuclear power plant. This 450 megawatt unit has been in operation since 1968. At present, two additional units are under construction at the San Onofre site, each of which will produce 1,180 megawatts. To produce the output of these two units in a fossil-fueled plant, it would require the burning of an estimated 25 to 30 million barrels of oil a year. Commercial operation of these two plants is planned for 1981 and 1982.

ENERGY SOURCE FACT SHEET

NUCLEAR FUSION

Source

Hydrogen isotopes in a controlled thermonuclear reaction

Collection

The hydrogen isotopes are separated from common water, (or sea water).

Transportation

The fuel for the fusion reaction would probably be moved in tanks as a compressed gas. It would be used in fusion reactors to generate electricity.

Storage

Electrical power can be stored in pumped water storage, hydrogen (and later run through a fuel cell), or in a large battery bank.

Use

Generation of electricity; separation of hydrogen from water; changing radioactive wastes into harmless substances; desalting seawater.

Consequences

If fusion can be developed, there is enough fuel on earth to produce hundreds of times as much power as used today for millions of years. This power would be generated almost pollution free.

Availability

Is still in the research stages. General Atomic anticipates the first demonstration power reactor to be operating in the 1990's. Operating powerplants will not be providing much of the United States' energy needs in the first decade of the 21st century. Nuclear fusion is not a solution to energy needs of the immediate future.

What is Nuclear Fusion?

In a fusion reaction, light atoms (such as hydrogen isotopes) are forced together under great pressure. During this change, large amounts of energy are released.

The U.S. Department of Energy (DOE) believes the first small-scale experimental fusion reactor will be working by the late 1980's, and a scaled-up demonstration fusion reactor by the late 1990's.

ENERGY SOURCE FACT SHEET

ORGANIC WASTE AND REFUSE

Source

Urban and agricultural wastes

Collection

Garbage collection, sewage, industrial refuse

Transportation

Trucks, sewer systems

Storage

Dumps, sewer treatment plants, municipal garbage incinerators

Use

Decomposition produces methane gas (like natural gas) which could be used as a fuel for heat. Flammable wastes can also be used as a fuel.

Consequences

Cost of building municipal methane plants and family-size converters would be offset by the production of a usable fuel. Methane gas would help to replace dwindling supplies of natural gas. Burning waste produces smoke and fumes which must be controlled to prevent air pollution.

Availability

The energy potential from waste could be expected to provide up to 3% of the total United States' energy needs, or up to 10% of our electrical needs.

What Is Organic Waste and Refuse Energy?

It comes from converting city and farm organic wastes to methane gas and would reduce the huge mass of refuse in this country by half or more. As a bonus, these new supplies of methane would serve to conserve or replace the dwindling fossil deposits of natural gas (primarily methane gas).

Consider these statistics: About 1.5 billion tons of city and farm waste are produced each year. This waste will increase as the population grows. Each pound of organic waste will produce about ten cubic feet (.29 m^3 of methane gas. If all this waste were processed for methane gas (probably an impossible task), we could have about 30 trillion cubic feet (857 billion m^3) of methane each year. This is about half again as much natural gas as the United States uses at this time. However, if conservation efforts to reduce waste are successful, less waste will be available as a source of energy.

Every city sanitation facility in the country could include a methane converter facility. Also possible, would be a family-size garbage converter attached to the house that could provide much of the fuel needed for cooking and heating. Production of methane gas from organic wastes and refuse could contribute to solving tomorrow's energy and waste-disposal problems.

Cost

To convert refuse to fuel is more expensive than present waste disposal techniques and exploration for offshore natural gas. But its potential makes it a logical choice as an alternative energy source.

ENERGY SOURCE FACT SHEET

PETROLEUM (OIL)

Source

Underground deposits throughout the world (under the sea floor in some locations)

Collection

Oil drilling

Transportation

Pipelines, oil tankers (truck, railroad, seagoing tankers)

Storage

Above-ground and underground storage tanks

Use

Fuel for producing heat which can be used to generate electricity or to produce mechanical energy; fuel for transportation and heating; raw material for petroleum based products and chemicals (plastics).

Consequences

Limited supply, high cost and supply uncertainties of imported oil; environmental impact and cost of drilling for new sources (e.g., offshore drilling); risks in transporting crude oil via pipeline or tanker (Alaskan pipeline); air pollution problems. Seventy-five percent of the present United States energy requirements are supplied by oil and natural gas.

Availability

Estimates vary, depending on role of use and how much is imported from other countries. At best, relying only on maximum United States resources, we have enough oil to only 35-40 years, or until the year 2015.

What is Petroleum?

Petroleum is fossil fuel made by millions of years of heat and pressure of the earth on organic materials. Petroleum is burned to release its energy.

If petroleum is used at expected rates, experts believe that by the year 2000, 90% of the world's oil may be exhausted. The current American use of oil requires increasing imports from Latin America and the Middle East. This is in addition to the use of the Alaskan pipeline to tap the North Slope oil reserves.

Importing oil has several effects on America. American dollars go out of the country and into oil-producing countries. Increased oil importation requires construction of oil supertankers with offshore ocean terminals. To ease the problems of oil importation, the United States is developing its own oil supplies, including offshore drilling.

However, the use of oil has severe environmental effects. The U.S. Office of Science and Technology reports that motor vehicles account for 44% of the country's air pollutants. Stationary fuel combusion of oil (powerplants and industry accounts for 16%. According to this report, vehicles give off 65% of the carbon monoxide, 46% of the hydrocarbons, and 37% of the nitrogen oxides. In addition to emissions, one must consider the possible environmental cost of more oil spills and petroleum-related pollution of the ocean, lakes and streams.

The environmental impact of oil utilization can be reduced through techniques such as hydrogenation to yield sulfur-free fuel. Exhaust emission control systems somewhat reduce the harmful effects of automobile emissions, but the cost and increased fuel consumption caused by these devices is considerable.

Oil shale (a limestone-like rock that is heated to release it oil) could also be used to increase petroleum supplies. Of course, getting oil shale presents all the usual mining problems plus the negative effect on the land at and near the mine sites. Large quantities of water are used in this process. The limited supply of water available in the areas where oil shale is found has restricted the use of this resource. Some experts estimate that energy expended to extract oil from shale may well equal if not exceed the energy the shale will provide.

Cost

As of 1974, heating an average home in California using only oil would cost $210.

SEA POWER (TIDAL, SEA THERMAL, AND WAVES)

Source

Oceans, currents, tides, and waves

Collection

Turbines run by incoming and outgoing tides or ocean currents; generating plants 200 feet (61m) beneath the surface of the sea (thermal); storing water in tanks above sea level; or using floats to operate booms which turn a generator.

Transportation

Varies depending on the form of collection

Storage

Hydrogen gas in tanks for electrical storage, batteries, and water in tanks above sea level for waves.

Use

Generate electricity, or in the case of sea thermal, hydrogen to produce heat or electricity

Consequences

Restrictions on recreation and fishing near these plants and cluttered beach areas

Availability

There are few places in the world where there is enough variation in tides to generate electricity efficiently. Limited number of sites for sea thermal, changes in wave power, and the number of waves limit the places where this power is feasible. Major ocean currents are often not close to land.

What is Sea Power?

Tidal sea power is possible along a coast where there is a high rise in tide. At high tide water flows through turbines into a bay, and during low tide, it flows back out. Conversion to energy is possible only during tidal flow, about 3-1/4 hours each way twice a day along the Pacific coast. Thus energy is generated for only 13 out of 24 hours. There are only a few places in the whole world where this is practical.

Sea thermal power is possible because of the difference between surface, warm sea temperature, and cold, deep water temperature. A gas (like freon used in refrigerators) at sea level would turn a generator, then be pumped deep to be cooled into a liquid, and then be brought to the surface to expand into a gas and turn the turbine. The electricity generated would be transported to shore through cables.

Waves could generate electricity by forcing water through valves in pipes into a tank above sea level. This water would run a turbine on its way back to sea. Or, floats could be mounted along the shoreline, connected with the shore by a long boom. The up-and-down motion of each boom would turn a generator.

Cost

Costs for these ideas are fairly high, too high in comparison to present alternatives. Also, the efficiency factor is low, with the possible exception of the sea thermal alternative. Costs are roughly twice as much as conventional power plants.

FACT SHEET

SOLAR ENERGY

Source: Sunlight

Collection: Photo cells (photovoltaics): metal panels, metal or plastic piping, plastic or rubber hose containing water or air to be heated, collected through photosynthesis in plant life; "solar farms".

Transportation: Varies, depending on the form of collection.

Storage: Heated water, heated air, batteries, and stored in the form of plant tissue through photosynthesis.

Use: Can be converted directly to electricity, used to heat water which in turn can power generators to create electricity, convert to nonpolluting fuels like methane and hydrogen, food energy in plants.

In order to gather solar energy, large arrays must be built. It is estimated (IPRI) that 47 square miles of solar arrays (collectors) would be required to produce 1 billion watts of electrical energy.

The Department of Energy report "Distributed Energy Systems in California's Future" says 70 square miles of land will be required to produce 100 million watts of electrical energy.

The conversion of light rather than heat into electricity involves photovoltaic conversion whereby solar cells exposed to the sun deliver electric current. Cadmium sulfide and crystal silicon cells are expensive to produce. Based upon present technology using solar cells to generate electricity is still 100-200 times more expensive than using conventional nuclear fueled plants.

The use of solar energy to assist in space and water heating may reduce somewhat the dependence upon fossil fuels for heating.

ENERGY SOURCE FACT SHEET

WIND

Source

A daytime heating and nighttime cooling of the atmosphere which produces winds.

Collection

Windmills, sails, wind turbines

Transportation

By wire (when used to produce electricity): by pipe, truck, or ship (when used to produce hydrogen)

Storage

None directly; as hydrogen gas in tanks. Storage possibilities for mechanical and electrical energy include improved batteries, flywheels, pumped water storage (pumping water to an elevated tank, then releasing the water to drive turbines), and compressed air storage.

Use

Wind can be used as kinetic energy (as with sail boats), or converted to mechanical, electrical or chemical energy.

Consequences

Low cost, renewability, and the fact that the methods of harnessing wind power do not degrade the environment give this source of energy a good potential. However, many windmills spread across a mountain range, open plain, or valley might be unsightly. A Department of Energy official has calculated that it would take 1,500 windmills with 300 foot-long blades to generate 1 billion watts of electricity. He added,"That would be a row of windmills 870 miles long, all taller than the Coronado bridge." Wind power requires 10,000 times more space than coal or nuclear power plants.

Availability

Wind power can be used almost immediately on both large and small scales. The technology to use this source of power is already available for small-scale use and there should be little difficulty in designing efficient large-scale systems.

What Is Wind Power?

For over 4,000 years wind has been used to produce power for pumping water, milling grain, and moving vehicles such as boats. Recently our use of wind as an energy source has declined because it was thought that there were other cheap fuels (petroleum, coal, nuclear, and hydroelectric). However, costs of fossil fuels have gone up as the supply as gone down. There are few new sites available for hydroelectric power. There are environmental worries about nuclear energy. All these have given renewed hope for wind as a significant power source.

Frank Rom of NASA thinks that half the electric power needs of the United States could be met by placing wind machines, one per square mile, throughout the Great Plains of the Midwest. Another possibility might be to place windmills on floating platforms off the Atlantic or Pacific Coasts. Of course, there are problems with unreliable wind speeds. Some of these could be overcome by moving many windmills into areas where wind is strong, steady, and predictable.

To solve the problems of unpredictability and storage of wind generated power, different systems to convert and store the power are now possible. One solution is to use wind power to electrolyze water. This will produce hydrogen gas, a flammable fuel which could then be stored and transported through pipelines as needed. Improved batteries, flywheels, pumped storage of water, and compressed storage of air are also possible answers.

The major project now is to design efficient, economical windmills to aid energy needs in both developed and developing nations. It is possible that small windmills, along with solar energy absorbers and waste recyclers, could provide total energy needs for individual homes.

Wind power is self-renewing, nonpolluting and plentiful. It shows high promise as a major source for our future energy needs.

Cost

Cost for wind generated power on a small scale (individual homes or farms) is about the same or a little more than current electrical costs. Large-scale operations are presently more expensive; low mass production techniques and higher fuel costs will soon make them equal.

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GOALS AND OBJECTIVES FOR ENERGY EDUCATION IN SAN DIEGO COUNTY

All students attending the primary, elementary, and secondary schools in San Diego City and County need to know that modern civilization is dependent upon vast amounts of energy to drive the wheels of industry, agriculture, transportation, and to provide people with warmth to protect their health and welfare.

Because the flow of energy into and within the United States is under jeopardy, the San Diego City/County Schools Energy Education Committee was formed in the spring of 1975 to bring to teachers' attention the problems our country is confronted with concerning energy supply and demand.

The committee is dedicated to motivating teachers to help their students learn there are challenges ahead of them to overcome these energy problems. In order to help this process, the committee has developed this set of energy education goals and objectives as its guideline for developing conferences, curriculum materials, and inservice workshops.

The goals and objectives are divided into two parts. Part I contains three program goals which are background for, and in support of, the five student goals which make up Part II of the document. The program goals are stated without accompanying objectives, but the student goals do have objectives that delineate what learners should accommodate and assimilate as part of their body of knowledge.

There are two ideas that permeate the goals and objectives: first, the concept that energy and environment are interwoven is expressed as "energy/environment," and second, as these goals and objectives are implemented, as many local examples as possible will be used to illustrate the objectives.

1977 Theme: "Energy Futures - What's Ahead?"
1975 Theme: "Energy - Environment - Economics" 1976 Theme: "Energy Conservation"

4. Students will be aware of future alternative sources of energy and the consequences of each.

    a. Types of energy sources.

    b. Cost/efficiency of energy conversion to end uses.

    c. Renewable vs. nonrenewable sources.

    d. Environmental concerns.

    e. Encouragement for developing new processes and products.

    f. Knowing about career opportunities.

Goal Number 2:

Conservation of Energy is an Important Immediate Necessity

To help our nation more effectively utilize its limited energy resources, we will have to resort to several forms of conservation including turning off lights, insulating buildings, driving more efficient cars, and many other methods; some will be voluntary and others will be mandatory; conservation should be viewed as another "source" of energy in the sense that energy which was previously wasted can be productively used to meet needs elsewhere in the economy.

Objectives:

1. Students will know the ways they (personally) use energy.

    a. Direct uses.

    b. Indirect uses.

2. Students will know the various ways their society and industry utilize energy.

3. Students will make an analysis of energy uses regarding how much energy is received as compared to the amount needed to produce it.

4. Students will know conservation techniques, including the energy efficiency techniques and how they are applied in homes and industry.

5. Students will understand the consequences of their choices and decisions upon energy problems.

    a. Voluntary.

    b. Mandatory--pricing, rationing.

6. Students will learn that conservation is an alternate energy source.

    a. Historically, resources were treated as unlimited.

    b. Energy conservation is a recent concept that can yield benefits for our society.

    c. Realization that energy resources are limited (therefore, the need for conservation).

    d. Rededication to the conservation ethic.

Goal Number 3:

Understanding the Economics of Energy/Environment Utilization

The economics theme will impinge upon each of the other themes - everything has a cost - and it is important for students to know what these financial and environmental costs are.

Objectives:

1. Students will know the economic perspectives of energy costs.

    a. Every activity involves an energy cost as well as an economic cost.

    b. The real cost of anything is what you give up to get it.

2. Students will know how the individual relates to the economic system in determining energy costs.

    a. Consumption involves both direct and indirect uses of energy and costs.

    b. Production involves both direct and indirect uses of energy and costs.

        (1) Comparison of end-use efficiency costs.

        (2) Conversion of energy vs. additional capital costs.

        (3) Funds spent on research and development may make new sources of energy competitive with current sources of energy.

3. Students will know how pricing influences energy costs.

    a. The laws of supply and demand in an open market.

    b. The laws of supply and demand in a regulated market.

4. Students will learn how political and economic decisions are intertwined.

Goal Number 4:

Understanding the Political Aspects of the Energy/Environment Problem

Whether the international, national, or local political window is being viewed, students need to know how foreign nations, along with national and local political leaders influence the solutions to broad-based problems of this nature.

Objectives:

1. Students will determine their individual household energy policies.
2. Students will understand the need for a national energy policy.
3. Students will understand what the existing local, state, regional, national, and international policies are, and know they are constantly changing.
4. Students will understand how and why policies are formulated.
5. Students will understand how individuals affect household, local, state, regional, national, and international policy.
6. Students will understand how groups affect household, local, state, regional, national, and international policy.
    a. Consumers
    b. Conservation
    c. Labor
    d. Business
    e. Cartels
    f. Trade organizations
    g. Regulatory bodies
7. Students will perform a critique of existing energy policies to determine their effectiveness.
8. Students will be able to analyze information to determine bias as a means of making informed political decisions.

Goal Number 5:

Learning About the Social Aspects of the Energy/Environment Problem

For the energy problem to be meaningful, it must be felt on the home and neighborhood level. It is at this level that most people will be able to help ameliorate some of the energy problems. After that, people will then be more able to contribute to solving some of the larger social aspects associated with the energy problem.

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